

Millis Commuter Rail Extension Feasibility Study

Author

Thomas J. Humphrey

Contributing Analyst

Sanjay Kaul

Graphics

Kenneth A. Dumas

Cover Design

Jane M. Gillis

Cover photograph:

*Millis, Mass., station on former New York & New
England Railroad Woonsocket Line, 1972.*

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EXECUTIVE SUMMARY

Rail passenger service to Millis was last operated in 1967. This service used a branch line that diverged from the present Needham commuter rail route at Needham Junction and ran through the towns of Dover and Medfield. At present, most residents of towns on the former Millis route who use commuter rail drive to stations in nearby towns on other lines. Residents of Millis, Medfield, and Dover have recently expressed strong interest in reinstitution of commuter rail service on the Millis Line and have requested that the MBTA examine the feasibility of such service. This report presents the results of the feasibility study, which was performed for the MBTA by the Central Transportation Planning Staff (CTPS).

Project Description

The study analyzed a commuter rail extension to Millis on the same alignment used until 1967. The following operating strategy alternatives were examined: 1) running Millis trains through to Boston with stops at all intermediate stations; 2) running peak period express service between Millis and Boston with limited stops on the Needham Line; and 3) combining Millis Line trains with Needham Heights trains at Needham Junction. The operation of diesel multiple-unit (DMU) cars was also analyzed.

The map on page ES-3 depicts the route of the Millis Line. The ridership demand and land use analyses indicate that in addition to a terminal in Millis, the extension should include one station each in Medfield and Dover. Cost calculations were based on a Millis terminal at the former Clicquot Station site west of Union Street. Identification of specific station locations would require further study. The distance from Needham Junction to the Clicquot site would be about 9.5 miles. Other potential station and terminal sites are discussed in the main body of the report. Based on rail distance from South Station, a Millis station would be in fare Zone 5. A Medfield station would be in Zone 4, and a Dover station would be in Zone 3.

Ridership Potential

The towns of Dover, Medfield, and Millis do not currently receive direct commuter rail service. Because of the close proximity of the Millis Line to other existing commuter rail lines, a Millis extension would, for the most part, only attract riders from the towns it directly served.

Ridership projections for a typical weekday at 1996 travel levels are shown in Table ES-1. Combining Millis Line trains with Needham Heights trains at Needham Junction with either through cars (Alternative 3) or connecting service would reduce ridership significantly compared with running separate through trains, because of the increased trip times resulting from passenger transfers or coupling and uncoupling cars.

Local and express service (Alternatives 1&2) would attract new transit riders at existing stations on the Needham Line as a result of more frequent headways and reduced travel

times. Similar ridership increases at existing Needham Line stations could be achieved by increasing service frequency or adding express service without a Millis extension.

The predominant source of ridership on all MBTA commuter rail lines is work trips to Boston and Cambridge. These account for 85% of the total ridership on existing South Side Commuter Rail lines. Based on the shares of work trips captured by these lines from communities at comparable distances from Boston, and taking into account relative travel times by rail and highway, a Millis extension could be expected to capture up to 75% of the work trips to downtown Boston from Medfield, Millis, and Medway. From Dover, the maximum share would be 60%. Because of competition with the Framingham/Worcester Line, the extension would capture under 15% of downtown Boston work trips from Sherborn.

Table ES-1
 Millis Extension Alternatives
 Estimated Weekday Inbound Riders by Category

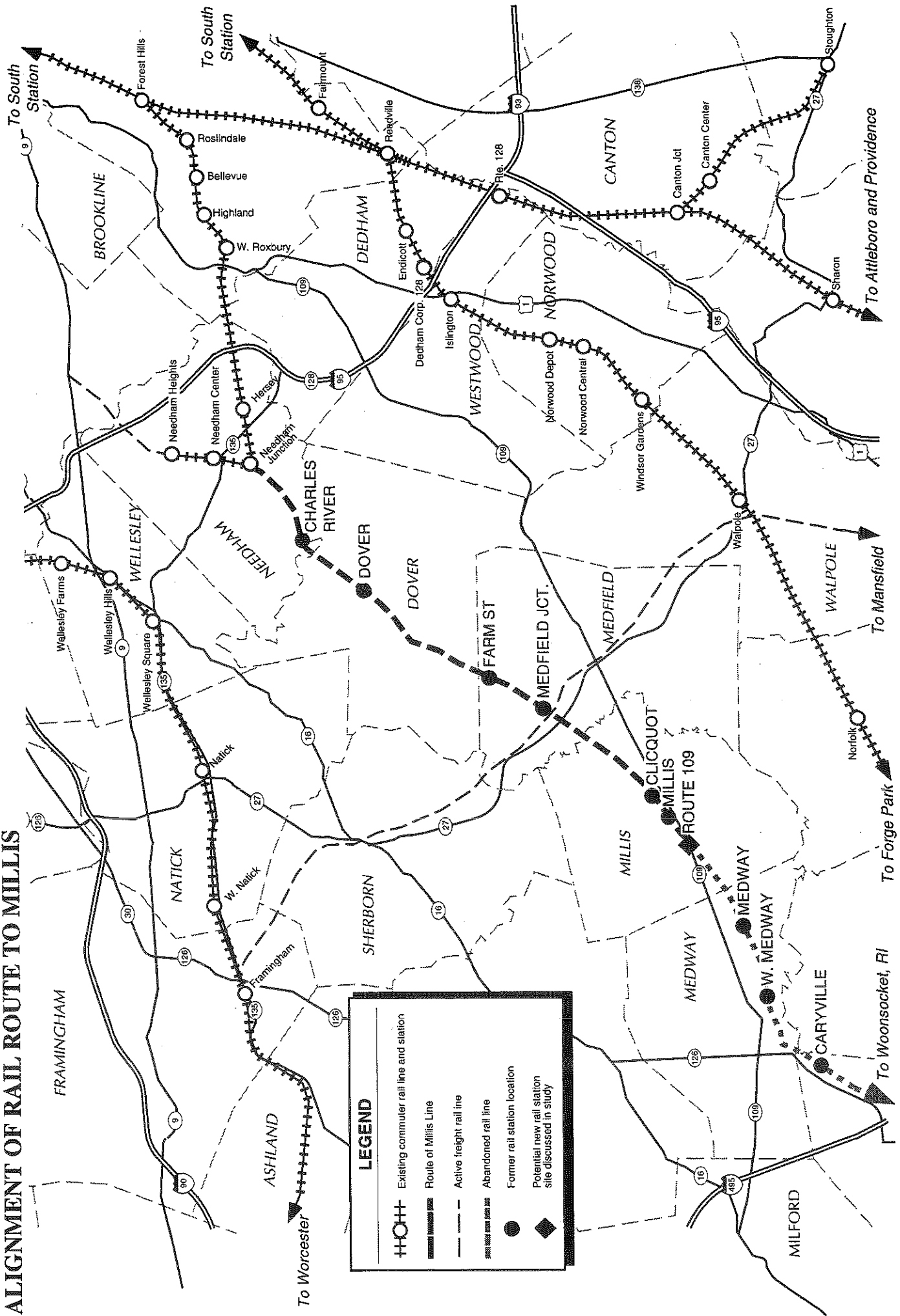
<u>Ridership Category</u>	<u>Local Service Only</u>	<u>Peak Express/ Off-peak Local</u>	<u>Combined Millis and Needham Heights Trains</u>
New Transit Users at Extension Stations	425	545	365
New Transit Users at Needham Line Stations	<u>425</u>	<u>470</u>	<u>105</u>
Total New Transit Users (1996 travel levels)	850	1,015	470
Existing Transit Users Diverted to Extension	785	815	785
Total Boardings on Extension (1996 levels)	1,210	1,360	1,150
Total New Transit Users (year 2020 travel levels)	990	1,185	565

Ridership projections utilized the most recent available figures for work travel to Boston and Cambridge by town of origin from the 1990 U.S. Census. Adjustments were made to obtain both year 1996 and year 2020 ridership levels. Allowances were also added for other destinations and trip purposes.

Overall Boston/Cambridge employment was essentially the same in 1996 as in 1990. It was therefore concluded that forecasts based on 1996 journey-to-work data, had it been available, would not have differed significantly from the 1990 forecasts.

MILLIS COMMUTER RAIL Feasibility Study

ALIGNMENT OF RAIL ROUTE TO MILLIS



Projections indicate that total employment in the city of Boston will show a net increase of about 5% between 1990 and 2020. During this same period, the Millis extension service area is expected to show population growth of 27%. Growth in individual towns in the service area is projected to range from 17% in Millis to 46% in Medway.

Assuming that commuter rail ridership would grow at the same rate as population in the service area, the year 2020 ridership projections would be as shown on Table ES-1. It is unlikely that commuter rail ridership from the service area would grow at a much greater rate than population. Increased suburban employment opportunities could result in Boston work trips, and hence commuter rail ridership, growing more slowly than population.

Capital Cost Estimates

Estimated capital costs for a Millis extension to Clicquot are summarized in Table ES-2. It should be noted that these are based on a preliminary examination of the facilities needed rather than on detailed engineering studies. The extension would use a rail line that is still used for freight service, but the track is in poor condition and would need to be entirely rebuilt to make it suitable for passenger service. New rolling stock would have to be purchased for this service, as the present commuter rail fleet is fully utilized.

Table ES-2
Summary of Capital Costs
for Millis Extension

<u>Item</u>	<u>All Local Service</u>	<u>Peak Express/Off-Peak Local</u>	<u>Combined Millis and Needham Trains Push-Pull</u>	<u>Combined Millis and Needham Trains DMU</u>
Total Infrastructure Cost	\$62,945,000	\$64,000,000	\$61,505,000	\$61,505,000
Total Equipment Cost	<u>\$48,550,000</u>	<u>\$48,550,000</u>	<u>\$31,590,000</u>	<u>\$47,490,000</u>
Total Capital Cost	\$111,495,000	\$112,010,000	\$93,095,000	\$108,995,000
Capital Cost Per New Transit Rider (year 2020)	\$112,621	\$94,523	\$164,770	\$192,912

Operating Cost and Revenue Estimates

Operating costs for a Millis extension would be determined primarily by the length of the route and the number of train trips operated each day. For each alternative, costs were calculated as the difference between combined operating costs for Needham and Millis trains with the extension and costs for present Needham Line service alone. Costs for combined trains were calculated both for push-pull trains and for DMUs.

Table ES-3 summarizes the incremental revenues and operating costs and revenue-to-cost ratios for the three service alternatives considered. (Costs are shown for service operating Monday through Saturday only, to provide the most direct comparison with existing Needham Line service.) In 1996 the ratio of revenue to operating cost for the existing MBTA commuter rail system as a whole calculated by methods comparable to those used for this study was about 42%. The annual operating cost for the Needham Line calculated by the same method was \$4,990,000, and it had a revenue-to-cost ratio of about 50%.

Table ES-3
Cost and Revenue Comparisons
for Millis Extension Service Alternatives

<u>Item</u>	<u>All Local Service</u>	<u>Peak Express/ Off-Peak Local</u>	<u>Combined Millis and Needham Trains Push-Pull</u>	<u>Combined Millis and Needham Trains DMU</u>
Annual Operating Cost Increase	\$7,730,000	\$7,730,000	\$2,855,000	\$2,710,000
Incremental Fare Revenue	\$1,100,000	\$1,300,000	\$670,000	\$670,000
Revenue-to-cost ratio	14.2%	16.8%	23.5%	24.7%
New Transit Riders (year 1996)	850	1,015	470	470

Environmental Impacts of Millis Extension

Impacts on Air Quality

Based on the present travel modes of the expected users of Millis rail service, and including new ridership on the Needham Line resulting from operation of Millis service, express service from Millis would reduce automobile vehicle miles of travel (VMT) by 37,870 per day. With local service only, the reduction would be 31,945. With Millis and Needham Heights trains joined east of Needham Junction, the VMT reduction would be 23,625 per day. Taking into account increased emissions from additional diesel locomotives or DMUs, the net impacts on air quality would be as shown in Table ES-4.

Other Environmental Impacts

A Millis extension would not have any other significant adverse impacts on the environment. Bridges and other segments near water would be provided with appropriate drainage systems to prevent brake dust and oil from trains from entering waterways. Parking lots would likewise have drainage systems that would capture pollutants from automobiles.

Table ES-4
 Millis Extension
 Net Change in Average Weekday VMT and Emissions

	<u>All Local</u>	<u>Express/Local</u>	<u>Combined Trains Push-Pull</u>	<u>Combined Trains DMU</u>
VMT Reduction	31,945	37,867	23,625	23,625
CO change	-287.2 kg	-346.6 kg	-192.4 kg	-232.1 kg
NOx change	+298.8 kg	+288.8 kg	+285.6 kg	+32.1 kg
VOC change	-18.1 kg	-23.7 kg	-8.8 kg	-20.5 kg
PM change	+4.6 kg	+4.6 kg	+2.9 kg	+1.1 kg

Development along most of the right-of-way of the extension is relatively light, and few cultural resources would be impacted. About 110 houses are currently within 200 feet of the segment between Needham Junction and Clicquot. More development is likely to occur near the line in the future, however. Abutters to part of the existing Needham Line are likely to be impacted by the increased number of trains.

At Dover Center two churches and the Town Hall are within 300 feet of the right-of-way. Otherwise, no community or cultural resources are sufficiently close to the right-of-way to be impacted by an extension to Clicquot.

A Millis extension would not reduce traffic significantly on any highway. The maximum absolute reduction would occur on the Mass. Turnpike east of Route 128, where auto diversions in the peak half hour would equal less than 3% of the capacity of the road. The maximum percentage reduction would occur on Route 109 east of Medfield, where traffic would be reduced by up to 15% in the peak half hour.

Peak auto arrival rates at stations on a Millis extension would be much lower than those at all existing stations on the outer end of the Franklin Line, now used by the largest number of riders from the Millis extension service area. In the final minutes prior to departure of the most heavily patronized train, auto arrivals at the busiest station would average about 11 per minute, and these would not all arrive from the same direction.

An extension from Needham Junction to Clicquot would have 10 grade crossings of public roads. None of these crossings appear to be heavily traveled.

Conclusions

A summary of the ridership and cost analysis results for the Millis commuter rail extension alternatives is shown in Table ES-5. An extension to Millis from Needham Junction would be feasible from an operations standpoint, but would produce very limited benefits for the costs involved. The highest ratio of incremental revenue to incremental operating cost for any of the alternatives shown would equal slightly more than half that for the present MBTA commuter rail system as a whole.

Most of the alternatives would have relatively high capital cost per new weekday transit rider. For an extension to Millis with peak-period express service, the capital cost per new transit rider shown in Table ES-5 (\$94,523) is similar to that for the Newburyport extension, currently under construction (\$93,055).¹

Table ES-5
Summary of Performance Measures for
Millis Extension from Needham Junction to Clisquot

<u>Item</u>	<u>All-Local Service</u>	<u>Peak Express/ Off-Peak Local</u>	<u>Combined Millis and Needham Trains Push-Pull</u>	<u>Combined Millis and Needham Trains DMU</u>
Total Weekday Inbound Riders at extension stations (year 1996)	1,210	1,360	1,150	1,150
New Inbound Transit Riders at New stations (year 1996)	425	545	365	365
New Inbound Transit Riders at Existing Stations (year 1996)	425	470	105	105
Total New Transit Riders (year 2020)	990	1,185	565	565
Annual Operating Cost	\$7,730,000	\$7,730,000	\$2,855,000	\$2,710,000
Incremental Fare Revenue (year 1996)	\$1,100,000	\$1,300,000	\$670,000	\$670,000
Incremental Revenue/Operating Cost	14.2%	16.8%	23.5%	24.7%
Total Capital Cost	\$111,495,000	\$112,010,000	\$93,095,000	\$108,995,000
Capital Cost/New Rider (year 2020)	\$112,621	\$94,523	\$164,770	\$192,912
Capital Cost/Kg of Weekday VOC Reduction	\$6,159,945	\$4,726,160	\$10,578,977	\$5,316,829

¹The most recent estimated capital cost per new transit rider for the Worcester extension, which was the most cost-effective commuter rail extension examined in the PMT, is \$45,732.

1. INTRODUCTION

Rail passenger service to Millis was last operated in 1967. This service used a branch line that diverged from the present Needham commuter rail line at Needham Junction and also ran through the towns of Dover and Medfield.¹ Until 1966, service had continued west of Millis to West Medway. At one time, this line continued beyond Medway through Bellingham and Blackstone to Woonsocket Rhode Island. The rail line between Needham Junction and Millis is now owned by the MBTA and is used for local freight service operated by the Bay Colony Railroad. Segments of the line west of Millis were abandoned and the land sold at various times between 1934 and 1967. Much of the right-of-way there is now obliterated.

At present, most residents of towns on the former Millis route who use commuter rail drive to stations on the Franklin or Needham lines, with smaller numbers going to the Framingham/Worcester or Attleboro/Stoughton lines. Residents of these towns have recently expressed strong interest in reinstitution of commuter rail service on the Millis Line and have requested that the MBTA examine the feasibility of such service. This report presents the results of the feasibility study, which was performed for the MBTA by the Central Transportation Planning Staff (CTPS).

A Millis commuter rail extension has been the subject of at least two other studies since the discontinuance of passenger service in 1967. A study devoted exclusively to alternatives for the Millis line was performed for the MBTA in 1988.² That study was performed in response to legislation mandating an examination of the feasibility of restoring service as far as Route I-495 in Bellingham. Alternatives with service terminating at Millis or West Medway were also included. It was noted that extensive land-takings would be needed to provide a right-of-way between West Medway and I-495, but no estimates of the cost of such takings were included.

A Millis line extension was examined again for the 1994 MBTA Program for Mass Transportation (PMT). That analysis did not include any alternatives with service extending further west than Millis, because of the right-of-way problems beyond that point identified in the 1988 study. A Millis extension was recommended in the PMT as a long-range future project, but with relatively low priority.

The present study was intended to provide a more in-depth re-examination of a Millis extension. The PMT had suggested that alternative operating strategies not examined might result in lower operating costs for the extension. It was also felt that changes in commuting patterns since the PMT analysis was performed might result in higher ridership projections. With an improved revenue-to-cost ratio, a Millis extension would merit a higher priority than it was given in the PMT. The conclusion of the present

¹The official name of this line has changed several times over the years. For purposes of discussion in this study, it will be referred to as the Millis Line.

²See Sverdrup Corporation in association with Howard/Stein-Hudson Associates, Inc. and TAMS Consultants, Inc. *I-495/Bellingham Commuter Rail Extension Feasibility Study Final Report*, December 1988.

study is, however, that no alternative for the Millis Line would have a significantly higher revenue-to-cost ratio than was found in the PMT analysis.

A field inspection in conjunction with the present study confirmed the impracticality of attempting to restore service further than West Medway. Restoration of service between Millis and West Medway would be more feasible than restoration beyond West Medway, but would also encounter many obstacles. An analysis of a West Medway extension is contained in appendix F, but the conclusion is that compared with a Millis terminal the additional costs of a West Medway extension would greatly outweigh the additional benefits.

2. SERVICE AREA

Communities to Be Served

The majority of inbound passenger trips on existing MBTA commuter rail lines originate in the cities or towns served directly by those lines.³ Most other trips originate in towns adjoining those with stations. The outermost station on a line often attracts riders from greater distances than do the intermediate stations, but the size of the end-of-line attraction area may be limited by competition with other lines.

For reasons set forth below, the geographical area served directly or indirectly by a Millis commuter rail extension would be much smaller than the service areas of most MBTA commuter rail lines. The map on page 5 depicts the expected service area of a Millis extension. The number of riders, if any, attracted from towns beyond this service area would be negligible.

A Millis extension from Needham Junction would run through the towns of Needham, Dover, Medfield and Millis. Historically, Needham and Dover each had one station on the Millis Line and Medfield and Millis each had two. When these stations were first established most railroad passengers made their access trips by walking; highway competition for travel to Boston did not develop until many decades later.

With present-day population patterns such as those found in the Millis Line corridor, the majority of commuter rail passengers must rely on some form of automobile access even when stations are closely spaced. The travel time between any pair of stations increases directly with the number of intermediate stations. Longer travel times make rail service less attractive for through travel compared with driving, and short-distance ridership attracted by the additional stations is typically very small. Accessibility regulations now require much more elaborate, permanent, and costly platform facilities at new stations than were permitted in the past. All of these considerations dictate that a future Millis extension should have fewer stations than existed when passenger trains were previously run on the line.

For purposes of analysis, this study assumes that Dover, Medfield, and Millis would each have one station on a Millis extension, so they would be in its service area. The Needham/Dover town line is about two miles from Needham Junction. Historically, there was one station on the Needham segment of the Millis Line, at Charles River Street. This site is in one of the least densely developed sections of the town. Although some new housing is being built in this area, population per square mile will remain low. For most Needham residents, at least one of the four present Needham Line stations would continue to be more convenient than any station location on a Millis

³Results of the 1993 MBTA commuter rail survey show that on-line origins exceeded 67% on all but the Fairmount Line (65%) and the Attleboro/Stoughton Line (55%). The Attleboro/Stoughton Line has several large regional parking facilities near major commuting highways.

extension. Therefore, it is assumed that there would be no stations in Needham on the extension itself, and Needham is not included in the extension service area.

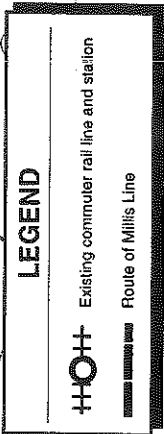
Other towns adjoining Dover, Medfield, or Millis to the north are Wellesley, Natick, Sherborn, and Holliston. Millis is bounded to the west by Medway. Towns adjoining Dover, Medfield, or Millis to the east or south are Westwood, Walpole, Norfolk and Franklin. Wellesley is served by three stations on the Framingham/Worcester Line and Natick is served by two. Westwood, Walpole, Norfolk and Franklin each have one or two stations on the Franklin Line and Westwood also has a station on the Attleboro/Stoughton Line. Population distributions and road layouts are such that insignificant numbers of residents of any of the towns with existing commuter rail stations would find stations on a Millis extension more convenient. Therefore, none of them are included in the service area of the extension. The other three adjoining towns, (Sherborn, Holliston, and Medway) do not currently have direct commuter rail service.

The 1993 commuter rail survey results showed that about 90 trips a day originated in Sherborn, with almost all of the boardings being made at stations on the Framingham/Worcester Line. A Millis extension would need to offer more attractive service than provided by that line in order to divert Sherborn residents from their present travel modes. As discussed in appendix B, a Medfield station with peak-period express service would reduce travel times for most Sherborn residents compared with local train service from Wellesley Square. Travel times via express train service from West Natick would be even faster than those via express service from Medfield Junction for the majority of Sherborn residents, however. Local service on the Millis Line would offer no travel time improvement for Sherborn residents except for a small number who now use stations on the Needham Line. Therefore, although Sherborn is assumed for purposes of this study to be in the service area of a Millis extension, ridership attracted from there would be relatively small.

The 1993 survey found that about 130 commuter rail trips originated in Holliston, with over 90% of the boardings being at stations on the Framingham/Worcester Line. Service on that line has subsequently been improved by the addition of express trains from Worcester stopping at Framingham, West Natick, and Natick. To divert Holliston residents from their present travel modes, a Millis extension would have to offer more attractive service than that of the Framingham/Worcester Line. No station on the extension with either express or local service would allow faster travel times to South Station or Back Bay from any point in Holliston than present Framingham/Worcester Line express service. Trains on a Millis extension would stop at Ruggles Station, which is not served by Framingham/Worcester Line trains, but Ruggles accounts for under 5% of ridership on routes that now serve it. For these reasons, Holliston is not included in the assumed service area of the extension.

The 1993 survey found that about 140 commuter rail trips originated in Medway, with 90% of the boardings being made at stations on the Franklin Line. From most points in Medway, access time to a station in Millis would be faster than that to any Franklin Line station, and combined access and train time to Boston even without express service

SERVICE AREA FOR MILLIS EXTENSION



would be faster than that via the Franklin Line. Therefore, Medway would be in the service area of a Millis extension.

Any towns in the service area of a Millis extension other than those discussed above would have to be beyond Medway in some direction. Medway is bounded to the north by Holliston, to the south by Franklin and Bellingham, and to the west by Milford. For reasons stated above, Holliston and Franklin would not be in the service area of the extension. Milford and Bellingham do not currently have direct commuter rail service. Most residents of these towns who now use commuter rail drive to Forge Park Station on the Franklin Line. Because of road layout, this would be a more convenient boarding location for residents of both towns than any station on a Millis extension. Therefore, neither one would be in the service area of such an extension. (An extension of the Franklin Line from Forge Park to Milford via Bellingham has been analyzed in another recent CTPS study, but the exclusion of Milford and Bellingham from the Millis extension service area does not depend on whether or not there is a Milford extension.)

Access to stations on a Millis extension from any towns not discussed above would require passing through one or more towns found to be outside the service area of the extension. From this, it can be concluded that no town not already discussed would be better served by a Millis extension than by an existing commuter rail line. Thus, the service area of a Millis extension would be limited to the on-line towns of Dover, Medfield, and Millis, and the adjoining towns of Sherborn and Medway.

Existing Transportation Services

Present Railroad Facilities in Service Area

A Millis commuter rail extension would use the right-of-way of the former Woonsocket Line of the New York, New Haven, & Hartford (New Haven) Railroad between Needham Junction and Millis. (For purposes of discussion in this report, it is referred to as the Millis Line.) The present end of track is at an industrial plant near the intersection of Pleasant Street and state Route 109 in Millis. Segments of the line west of this point were abandoned at various times between 1934 and 1967. Much of the right-of-way there has since been sold and obliterated. The segment from Needham Junction to the end of track in Millis is owned by the MBTA, and is currently used for local freight service operated by the Bay Colony Railroad.

Passenger service on the Millis Line was discontinued in 1967, when a subsidy contract between the MBTA and the New Haven Railroad was not renewed. In the final years, service had been provided by a single self-propelled railcar making one trip per day in each direction between Millis Line points and Needham Junction. In the morning, passengers for Boston usually had to transfer at Needham Junction to a train from Needham Heights. In the evening, the Millis car was typically run through from Boston attached to a Needham Heights train as far as Needham Junction. Until 1966, this service had continued beyond Millis into Medway, serving two stations there.

Dover and Millis have never been served directly by any railroad lines other than the Millis Line. Medfield is also on the route of the Conrail Framingham Secondary Track, as is Sherborn. The Framingham Secondary runs from a connection with the Framingham/Worcester commuter rail line at Framingham to a connection with the Attleboro/Stoughton Line at Mansfield. It connects with the Millis Line at Medfield Junction.⁴ It also connects with the Franklin Line at Walpole Station.

Because of its geographical orientation, the Framingham Secondary Track has always served primarily as a bypass route around Boston for rail traffic rather than as a route in or out of Boston. It is now used mostly for freight service, but is also used occasionally as a detour route for Amtrak intercity passenger trains. The portions south of Walpole also carry special MBTA trains to events at Foxborough Stadium.

Present Highway Facilities in Service Area

A Millis extension would be used predominantly for travel from communities in its corridor to Boston and Cambridge. No limited-access highways serve any of the towns in the Millis Line service area (shown on the map on page 5) directly. The most direct driving route to Boston from Medfield, Millis, or Medway involves the use of state Route 109, which has uncontrolled access and relatively low average speeds. Route 109 connects in Dedham with Route 128 (I-95), which can be followed north to the Mass. Turnpike at Weston. Based on available information, this would be the fastest highway combination from the outer three towns. Alternatively, drivers can continue north on Route 109 beyond Route 128 to the VFW Parkway in West Roxbury or to various local roads leading into Boston.

Route 109 also passes through the southern edge of Dover for a short distance, but access to this segment from most of the town is poor. Instead, Dover residents can use local roads through Needham or Dedham to access Route 128. From Sherborn, the fastest driving route to Boston, although not the most direct, is Route 27, Coolidge Street, and Speen Street to the Mass. Turnpike at Interchange 13 in Framingham.

Other alternatives for driving to Boston from points in the Millis Line corridor include heading southeast on various state highways or local roads to some point on I-95 and then north on that road and I-93 to Boston. The inner segment of I-93 is more congested than the Mass. Turnpike, however.

⁴The former level crossing of the Millis Line and the Framingham Secondary Track and about 1,500 feet of track on the Millis Line north of the crossing and 300 feet south of the crossing were removed in the early 1970s. Freight trains operating between the two segments of the Millis Line currently do so by using the connecting tracks on and off the Framingham Secondary.

Present Public Transportation Serving the Study Area

Commuter Rail

None of the towns that would be in the service area of a Millis extension are now served directly by any commuter rail lines. The 1993 survey results show that most residents of these towns who use commuter rail ride the Franklin or Needham lines, with smaller numbers taking the Framingham/Worcester or Attleboro/Stoughton lines. Table 2-1 summarizes the expanded survey results for weekday inbound trips originating in the expected service area of a Millis extension.

A total of 788 weekday inbound commuter rail trips originated in the towns that would be served directly or indirectly by a Millis extension. Walpole Station was the boarding point for the largest single share of these trips, (194 boardings, or 25%) followed by Norfolk (172 boardings, 22%). Needham Junction was third, with 122 of the boardings (15%). The rest were scattered among many stations, with only Dedham Corporate Center (45 boardings, 6%) serving more than 5%.

Other MBTA Service

No MBTA rapid transit, light rail, or bus service is operated directly in any towns in the service area of a Millis extension. The nearest boarding points for such service are Riverside Station (Green Line or express bus), other Newton stations on the Green Line, Forest Hills station on the Orange Line, and stations on the South Shore Branch of the Red Line. Survey results indicate that on a typical weekday about 60 residents of towns in the Millis extension service area go to stations on the Green Line, with about 40% of them originating in Dover. The Orange and Red lines serve about 10 riders each from the corridor, mostly from Millis or Medfield. About 10 other corridor residents (mostly from Dover or Medfield) board express buses at Riverside.

Private-Carrier Express Bus Service

Medway, Millis, Medfield, and Dover currently have through bus service to Boston. This is provided by a route operated by the Brush Hill Transportation Company, with assistance from the MBTA/EOTC Interdistrict Transportation Service (IDTS) program. There are now two inbound A.M. peak and two outbound P.M. peak trips, with no off-peak or weekend service. This route also serves Westwood and Milford, which would both be outside the Millis extension service area. These buses make several stops in each town except for Dover, which has only one stop. Sherborn is not served directly by any bus routes, but express bus service to Boston operated by Peter Pan Bus Lines is available at Shopper's World in Framingham.

Figures for the Brush Hill route published in the MBTA's Ridership and Service Statistics report show an average of 54 riders per day, or 27 in each direction, in fiscal 1996. This was a decrease of about 20% from 1990. Boardings by town are not shown. 1990 Census Journey-To-Work figures show 35 work trips by bus to Boston Proper, 10

Table 2-1
Weekday Inbound Ridership at Present Commuter Rail Stations for Trips
Originating in Millis Extension Service Area

Boarding Station	Origin					Total
	Medway	Millis	Medfield	Dover	Sherborn	
<i>Franklin Line</i>						
Forge Park	14	2				16
Franklin	17					17
Norfolk	88	82	2			172
Walpole	6		188			194
Windsor Gardens			3			3
Norwood Central			18			18
Norwood Depot			4			4
Islington			2			2
Dedham Corporate Center	4		39	2		45
Subtotal	129	84	256	2		471
<i>Needham Line</i>						
Needham Center				4		4
Needham Junction		10	46	60	6	122
Hersey		3	13	13	2	31
Subtotal		13	59	77	8	157
<i>Framingham/Worcester Line</i>						
Framingham	5				10	15
West Natick	3				18	21
Natick		3	3		18	24
Wellesley Square	3	6		25	29	63
Wellesley Hills					2	2
Wellesley Farms	2				2	4
Subtotal	13	9	3	25	79	129
<i>Attleboro/Stoughton Line</i>						
Route 128			23	8		31
Subtotal			23	8		31
Total	142	106	341	112	87	788

to the rest of Boston and 4 to Cambridge by Medway, Millis, Medfield, or Dover residents. These totals were expanded from a very small sample and are not reliable.⁵ Ridership figures by town of origin on the Shopper's World route are not available.

Feeder Bus Service

None of the towns in the Millis extension service area have feeder bus service connecting with commuter rail, rapid transit, or express bus routes to Boston from other towns.

Table 2-2 summarizes boardings on the mass transit alternatives discussed above by passengers with trips originating in Dover, Medfield, Millis, Medway, or Sherborn

Table 2-2
Weekday Inbound Ridership on Present Mass Transit Services for Trips Originating in
Millis Extension Service Area

<u>Existing Mass Transit Service</u>	<u>Riders from Millis Ext. Service Area</u>
Franklin Commuter Rail	470
Needham Commuter Rail	155
Framingham/Worcester Commuter Rail	130
Attleboro/Stoughton Commuter Rail	30
Green Line - Riverside through Newton Center	60
Orange Line - Forest Hills	10
Red Line - South Shore Branch	10
MBTA Express Bus Route 500	10
Private-Carrier Bus (est.)	<u>15</u>
Total	890

Note: Figures in this table are rounded to the nearest five, because they are based on expanded survey results rather than counts

⁵A one-day count by CTPS in May 1997 showed only 17 Boston boardings on the two outbound trips. Of these passengers, 5 boarded at South Station and 6 each at Park Square and Copley Square. An on-board count on one outbound trip showed 3 alightings in Westwood, 2 in Medway, and 1 in Milford, but none in Medfield or Millis. There were no boardings after the bus left Boston.

3. DESCRIPTION OF SERVICE

Alignment

A commuter rail extension to Millis from Needham would use part of the former New Haven Railroad Woonsocket Line, more recently known as the Bay Colony Railroad Needham Line. This line diverges from the Needham commuter rail line just west of the Needham Junction Station platform. At its maximum extent, it ran through Dover, Medfield, Millis, Medway, Bellingham, and Blackstone to Woonsocket, Rhode Island. The distance from Needham Junction to the former station site in Millis is 10.0 miles. The map on page 13 shows the rail lines that would be used for Millis service.

Service to Millis could be provided by through trains to Boston, by connection with Needham Line trains, or by some combination of these strategies. In any case, passengers would travel between Needham Junction and South Station via the present route of Needham Line trains, a distance of 12.0 miles. The total rail distance from South Station to the old Millis station site is 22.0 miles. A future station would be slightly nearer or further than this, as discussed in the next section.

Stations

Identification of specific station sites on a Millis commuter rail extension is beyond the scope of this study. For purposes of analyzing ridership, travel times, and traffic impacts of the extension, however, it was necessary to make some assumptions about approximate station locations. Actual station locations would be unlikely to differ sufficiently from those assumed to change ridership projections significantly. As discussed further in appendix E, good highway access and adequate parking facilities would be critical to the success of a Millis extension, but most of the station sites used in the past lack one or both of these elements. Therefore, some new sites were considered as well. The most promising sites are discussed below. Past station sites and potential future sites discussed in this report are shown on the map on page 13.

Prior to the present study, the most recent analysis of a Millis commuter rail extension was done for the 1994 MBTA Program for Mass Transportation (PMT). That analysis assumed that the extension would have one station each in Dover, Medfield, and Millis. The Dover station was assumed to be at Springdale Avenue, near the town center. The Medfield Station was assumed to be off Mill Street near the end of Adams Street. The Millis Station was assumed to be near Union Street. These sites would be near the former Dover, Medfield Junction, and Clicquot station locations, with some slight relocations to obtain more room for parking facilities.

Prior to the PMT, a commuter rail extension to Millis and beyond had been analyzed for the MBTA in 1988, in a study cited on page 1 of this report. That study also identified the Springdale Avenue, Mill Street, and Union Street sites as likely future station locations. An alternate Medfield station site south of Meadows Road (Route 27) was identified as a second choice. In Millis an alternate site at Route 109 about opposite

Hammond Lane was identified as a second choice. The former Millis station site west of Exchange Street was found to be unsuitable for a future station because of inadequate room for parking and present use of the historic station building as town offices.

For purposes of analysis, the present study also assumes one station each in Dover, Medfield and Millis, with approximate locations the same as those listed above for the 1994 PMT analysis. The alternate Millis site at Route 109 identified in the 1988 study was also examined in detail in the present study, but in almost every measure, the Clicquot site was found to be the better of the two.

Past passenger service on the Millis Line included stations at Charles River Street in Needham and at Farm Street in Medfield. For reasons discussed in the first section of chapter 2, it was assumed that a future Millis extension would not have any stations in Needham west of Needham Junction. The Farm Street station was only 1.1 miles from the former Medfield Junction site. It was never well patronized, and would be further from most trip origins in Medfield than the Mill Street site. Farm Street itself is less suitable than the roads to a Mill Street site would be to provide access to a commuter rail station. For these reasons, a future Millis extension is assumed not to have a station at Farm Street. Further details on past station sites and potential future sites, including the analysis of the Route 109 station site in Millis, are presented in appendix E.

Layover Facility

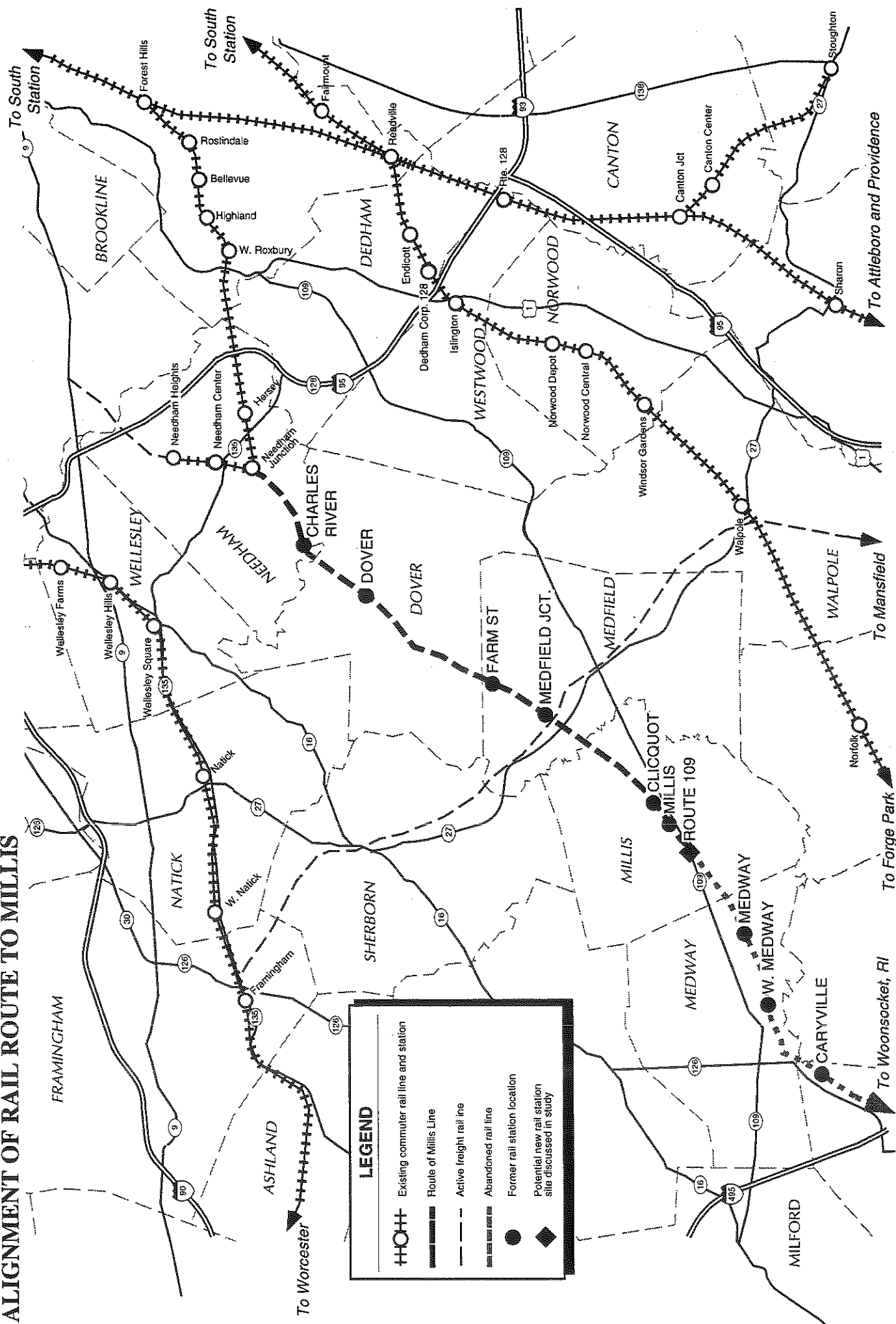
The rolling stock used on MBTA commuter rail lines does not necessarily require any special facilities at the end of a line. On single-track routes such as the Millis Line, trains can reverse direction at any desired location, with the engine pulling the train on the outbound trip and pushing it on the inbound trip or vice-versa. To minimize non-revenue train mileage, however, it is desirable to provide a yard for overnight storage of trains at or near the outer end of a route. A Millis extension would require a layover facility at or near the outer terminal to attain the operating costs estimated in chapter 6, but the necessary capacity of the facility would depend on the strategy adopted for serving stations on the present Needham Line. Several possible strategies are listed in the Running Times section below.

Service on the Needham Line now uses four train sets to cover five trips inbound in the A.M. peak and five trips outbound in the P.M. peak.⁶ Three sets are based overnight at a layover facility just south of the Needham Heights Station. In the morning one of these train sets covers the first and fourth inbound trips, and the other two cover the second and third trips. The fifth inbound trip is covered by a train set that runs out from Boston after completing a trip on another line.

In the P.M. peak one train set goes to the Needham Heights layover after making the first and fourth outbound trips, and one goes there after the third outbound trip. The third set ending at the Needham Heights facility makes the final outbound trip of the

⁶The Needham Line schedule referred to in this study had an effective date of May 12, 1997.

ALIGNMENT OF RAIL ROUTE TO MILLIS



day and also covers the fifth P.M. peak outbound trip. The set used on the second outbound P.M. peak trip eventually ends up at the Southampton Street yard in Boston.

Because of the longer distance from Needham Junction to Millis compared with that from Needham Junction to Needham Heights, Millis service running through to Boston on headways similar to those now used on the Needham Line would be likely to involve at least one more trainset, making a layover requirement of four sets. With less frequent service or operation of shuttle trains to Needham Junction instead of through trains, this requirement would be reduced.

Identification of a site for a layover facility for a Millis extension is beyond the scope of this study. With the amount of undeveloped industrially zoned land adjoining the right-of-way, it is reasonable to assume that such a site could be found. A small freight yard adjoining the Clicquot station site was formerly used in conjunction with service to nearby industries, but is currently underutilized. From an operating cost standpoint this would be the optimal location for a layover facility for trains terminating at Clicquot, as it would not require any non-revenue train miles. The locomotives used by the Bay Colony Railroad for freight service on the Millis Line are based on one of the sidings at the Clicquot yard, so there is a precedent for a railroad layover facility there.

If the Clicquot site cannot be used, the next nearest location would be adjacent to the Devco Products plant at the end of track in Millis. Access to this site would require upgrading of about one mile of track that would not otherwise be used by passenger trains terminating at Clicquot but is currently used by freight trains. (For an extension terminating at Route 109, the Devco site would require fewer non-revenue train miles than a Clicquot layover.) Possible environmental problems because of adjoining wetlands could rule out the Devco site, however.

Another possible layover site is an abandoned gravel pit north of Medfield Junction, about 2.3 miles from Clicquot. It would require operation of more non-revenue train miles than either of the other sites discussed above, but no more than are now required for trains based at some MBTA commuter rail layover facilities. (For example, the Franklin facility is 2.8 miles from Forge Park Station.)

Running Times

Commuter rail service to Millis would operate for 12 miles on the present Needham commuter rail line and for about 10 miles on a line that is now used only for local freight service. Because of deteriorated or missing tracks and structures, the extension would require complete reconstruction of the segment not currently used for passenger service.

Running times on the extension itself would depend on the number and locations of stations served, maximum speed limits, speed restrictions for curves and crossings, and the acceleration and deceleration characteristics of the rolling stock used. Running times between Needham Junction and Boston would depend on the operating

configuration adopted. Because of the location of the diverging point between the Needham and Millis Lines, Millis trains could serve any of the stations on the present Needham line except Needham Heights and Needham Center. This was an issue when Millis service was provided in the past, and would be an issue for future service. Operating strategies analyzed in detail for this study included the following:

- Millis trains running through to Boston, stopping at all stations from Needham Junction east, with no reduction in Needham Heights service.
- Millis trains running through to Boston, running non-stop from Hersey to Ruggles in peak hours and stopping at all stations from Needham Junction east in off peak hours, with no reduction in peak or off-peak Needham Heights service.
- Trains running between Boston and Needham Junction with cars for both Millis and Needham Heights, with trains splitting and combining at Needham Junction. As detailed in chapter 7, this could be done either with push-pull equipment or with trains of diesel multiple-unit (DMU) cars.

Alternatives discussed in the report, but examined in less detail include:

- Millis shuttle trains running only to Needham Junction, with passengers transferring to Needham Heights trains there.
- Shuttle trains running between Needham Heights and Needham Junction, with passengers transferring there to through Millis-Boston trains.

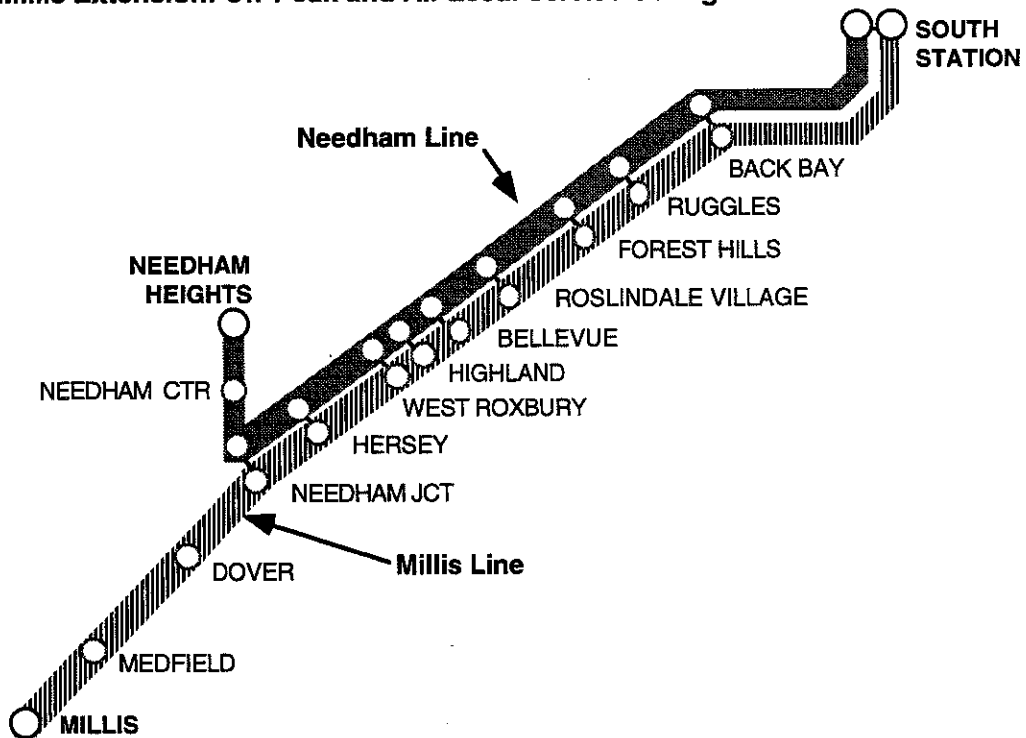
Additional possibilities not examined explicitly in this study would include:

- Diversion of some present Needham Heights trains to Millis, without direct replacement service at Needham Center and Needham Heights
- Diversion of all present Needham Heights trains to Millis, with connecting bus or light rail service to Needham Center and Needham Heights.

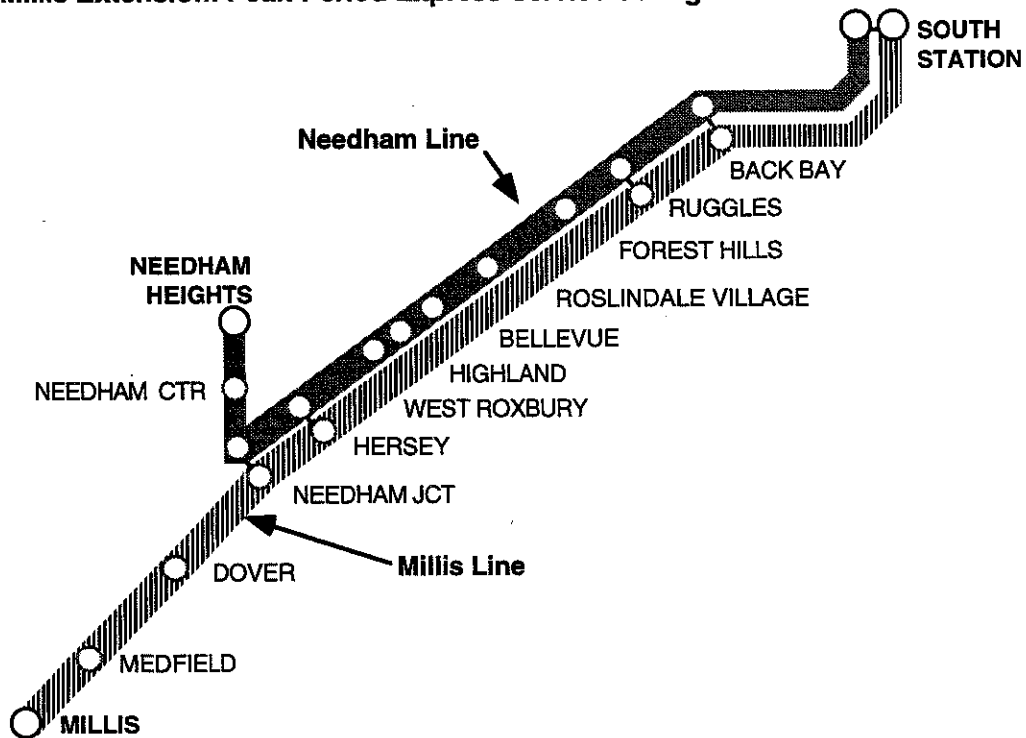
The diagrams on pages 16 through 18 show the stations that would be served by Millis and Needham Line trains under various operating strategies analyzed in this study. These are also described more fully in chapter 4.

Historically, the Millis Line never had very high speed limits. From Needham Junction to Millis, the maximum speed was 35 m.p.h. with a 20 m.p.h. restriction crossing the Framingham Secondary Track at Medfield Junction. For purposes of analysis, it was assumed that for future passenger service the line would be upgraded for a maximum speed of 60 m.p.h. throughout. This would result in running times to Needham Junction of about 15 minutes from Millis (Clicquot), 11 minutes from Medfield Junction, or 5 minutes from Dover. (These results are similar to with the times used in the 1988

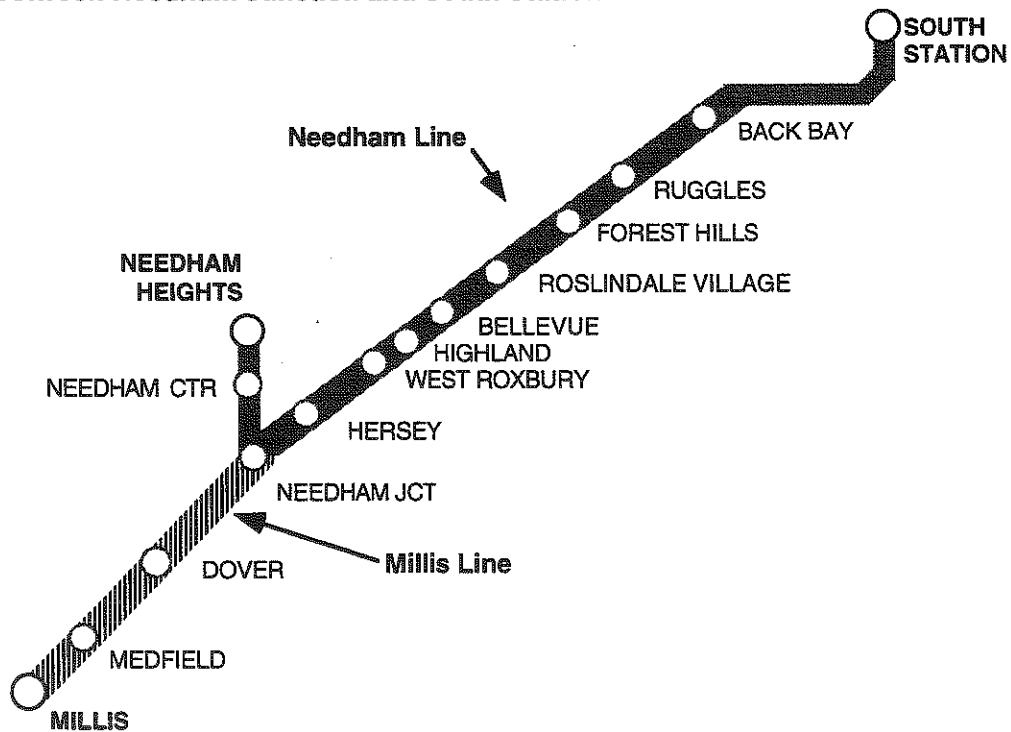
Millis Extension: Off-Peak and All-Local Service Configuration



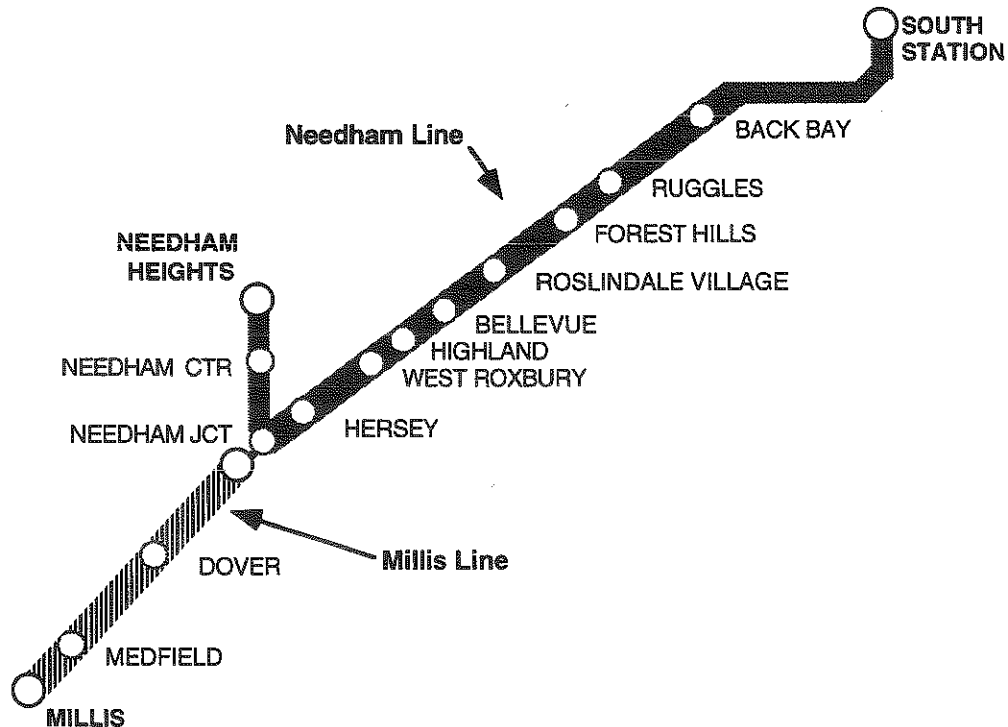
Millis Extension: Peak-Period Express Service Configuration



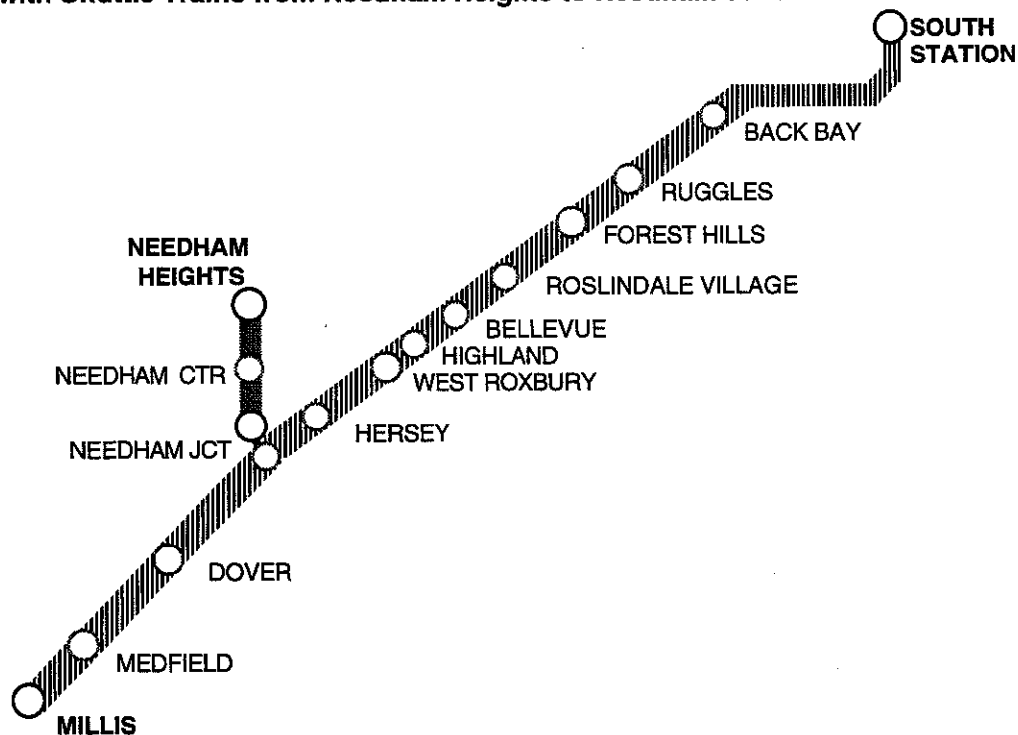
**Millis Extension: Millis and Needham Heights Trains Combined
Between Needham Junction and South Station**



**Millis Extension: Through Trains from Needham Heights to Boston
with Shuttle Trains from Millis to Needham Junction**



**Millis Extension: Through Trains from Millis to Boston
with Shuttle Trains from Needham Heights to Needham Junction**



study, but were re-calculated independently.) With the overall distances and station spacings involved, upgrading the line for maximum speeds of 80 m.p.h. would reduce the running time between Millis and Needham Junction by only about half a minute, with smaller reductions at Medfield Junction and Dover.

Between Needham Junction and Forest Hills, Needham Line trains run on the Needham Branch. The overall maximum speed limit on this line is 60 m.p.h. There are two short segments restricted to 45 m.p.h. and one 30 m.p.h. restriction because of switches, crossings, or curves. Between Forest Hills and South Station, Needham Line trains use the tracks of the former Boston & Providence Railroad, now designated by Amtrak as part of the New Haven-Boston or NHB Main Line. Present MBTA policy restricts the maximum speeds of commuter trains to 80 m.p.h., but the speed limit for intercity trains for most of the distance between Forest Hills and Back Bay on this line is 100 m.p.h.

At present, all peak-direction peak period trains on the Needham Line are scheduled to stop at Needham Junction, Forest Hills, and five intermediate stations. Scheduled running times from Needham Junction to Forest Hills range from 18 to 21 minutes, with an average of 19.5 minutes. Between Forest Hills and South Station these trains make intermediate stops at Ruggles and Back Bay. Scheduled running times range from 13 to 15 minutes, with an average of 14. Overall scheduled times from Needham Junction to South Station average 33.5 minutes.

Including an allowance for dwell time at Needham Junction, a Millis Line train serving all intermediate stops on the Needham Line would have scheduled running times to South Station of about 49 minutes from Millis, 45 minutes from Medfield Junction, or 39 minutes from Dover. Running times to Back Bay Station would be 5 minutes less than these. Running times could be improved significantly by having Millis trains make no stops or limited stops between Needham Junction and Ruggles. Eliminating all of the intermediate stops on this segment would reduce running time by about 13 minutes compared with the present scheduled average. This would result in times to South Station of 36 minutes from Millis, 32 minutes from Medfield Junction, or 26 minutes from Dover. Adding one intermediate stop at either Hersey or West Roxbury would increase these times by about 2 minutes each. The demand forecasts in chapter 4 assume that Millis express trains would stop at Needham Junction and Hersey.

Comparisons with Travel Times for Present Alternatives

Table 3-1 compares auto times to Boston via present highway alternatives from Millis, Medfield, and Dover with estimated travel times via a commuter rail extension from Needham Junction. (These comparisons do not include access times to boarding stops or egress times from alighting stops.) Multiple travel time runs have not been conducted recently over the full lengths of the driving routes to Boston from towns in the Millis extension corridor, but have been done on the limited-access highway segments most likely to be included in such trips. Current schedules for limited-stop buses using Route 109, and observed times on one such trip on a recent typical day, give an indication of traffic speeds on that road. Combining this information, the fastest driving route to Boston (though not the shortest one) from Millis or Medfield would be via Route 109, Route 128, and the Mass. Turnpike. From Dover, the fastest route would be via local roads to Route 128 in Needham and then via Route 128 and the Turnpike.

For auto trips starting near each of the three station locations assumed on a Millis extension, estimated driving times to the vicinity of South Station would be as shown in Table 3-1. These results show that a local rail service option would provide line-haul travel times 7 to 9 minutes faster than current driving times from Millis and Medfield, and about one minute longer than driving time from Dover. An express rail option with stops at Needham Junction and Hersey would provide travel times 10 to 20 minutes faster than driving.

Levels of Service

The amount of service operated on existing MBTA commuter rail lines varies among routes. Service on a Millis extension, as on other lines, would be adjusted over time on the basis of ridership experience. Schedules of Millis trains would need to be coordinated with those of other trains operating on the shared route segments, as discussed in chapter 7 and appendix D.

At present, service on the Needham commuter rail line includes five inbound trains during A.M. peak hours and five outbound trains during P.M. peak hours. Headways

Table 3-1
Comparison of Projected Train Times to South Station
from Stations on Millis Extension with Driving Times

<u>Boarding Station</u>	<u>Local Rail</u>	<u>Express Rail</u>	<u>Estimated Driving Time</u>
Millis (Clicquot)	49 minutes	38 minutes	58 minutes
Medfield (Junction)	45 minutes	34 minutes	52 minutes
Dover (Center)	39 minutes	28 minutes	38 minutes

are not uniform, but average about 35 minutes between peak trains. Off-peak headways range from one to two hours. The various strategies described above and in chapter 4 for operating Millis service would include Millis trains alternating with, connecting with, combining with, or replacing some Needham Heights trains. The maximum number of trains run on the extension would equal the number currently running on the Needham Line. This is 16 round trips on weekdays and 9 on Saturdays. (At present, there is no Sunday service on the Needham Line.) With through Millis-Boston trains added to Needham Heights service, there would be 32 round trips on weekdays and 18 on Saturdays on shared segments of the Needham Line.

Fares

MBTA commuter rail lines have a zone fare system. Zone limits are based nominally on mileage from Boston, but exceptions are made for reasons such as avoiding different fares at stations in the same town. Fare-payment options include single-ride or 12-ride tickets and monthly passes. (Survey results indicate that passes are used for an average of about 21 round-trips, or 42 rides, per month.) Senior citizens, children under the age of 12, high school or younger students, and persons with disabilities, are eligible for half fares. Table 3-2 compares the cost per ride to Boston on existing mass transit services used by residents of the Millis commuter rail extension corridor with fares that riders would pay on the extension. Fares at extension stations are assumed to be the same as those from stations at similar distances from Boston on existing commuter rail lines. These fares are described in greater detail below.

Based on track distance from Boston, a Millis station on an extension from Needham Junction would be in Zone 5, a Medfield Junction station would be in Zone 4, and a Dover station would be in Zone 3. From Zone 5, the respective costs per ride with a one-way ticket, 12-ride ticket, or pass used for 21 round trips per month are \$3.25, \$2.71, or \$2.48. From Zone 4 these costs would be \$3.00, \$2.50, or \$2.24. From Zone 3 the costs would be \$2.50, \$2.08, or \$1.95.

Based on present practice, there would be a \$1.00 per day parking fee at any station on a Millis extension route. For a passenger driving alone to the station, this would effectively add 50 cents to each of the one-way trip costs listed above.

Comparisons with Fares for Present Transit Alternatives

Among residents of towns that would be served directly or indirectly by a Millis extension, the most commonly used mass transit alternatives for travel to Boston or Cambridge are the south side commuter rail lines. Boarding stations vary by town of origin. According to the 1993 commuter rail survey, 79% of Millis residents who used commuter rail boarded at Norfolk Station on the Franklin Line. This station is in Zone 5, as a Millis station would be, so riders diverted to a Millis station would experience no difference in fares. About 12% of Millis rail users boarded at a Needham Line station in Zone 2, and about 9% used stations in Zone 3 or 4 on the Framingham/Worcester Line. All of these riders would pay more if they boarded at Millis.

Among Medfield residents who used commuter rail, the survey showed that 55% boarded at Walpole Station on the Franklin Line. This station is in Zone 4, as a Medfield Junction station would be. Another 2% used various other Zone 4 stations. These riders would experience no difference in fares if they diverted to a Medfield Junction station. About 12% of Medfield rail users boarded at a station in Zone 3, and about 35% used stations in Zone 2. All of these riders would pay more if they boarded at Medfield Junction.

Among Dover residents who used commuter rail, the survey showed that only 22% boarded at a station in Zone 3, where the fare would be the same as at a Dover station. The other 78% all used stations in Zone 2, and would pay higher fares if they shifted to a Dover station.

Medway, the outermost town in the Millis extension service area, would not have a station on an extension terminating in Millis, but had more commuter rail users than either Millis or Dover in the survey. Medway residents shifting to a Millis extension would be most likely to use the Millis station, in Zone 5. The survey found that 62% of Medway residents using commuter rail boarded at Norfolk Station in Zone 5 with another 4% using Framingham Station, also in Zone 5. The second-largest group (22%) boarded at Forge Park or Franklin, now both in Zone 6. (This is the only group that would pay lower fares by shifting from their present boarding station to the nearest station on a Millis extension.) The other 11% boarded at scattered locations in zones, 2, 3, and 4, and would pay higher fares if they shifted to a Millis station.

Sherborn would also not be served directly by a Millis extension. The extension station most likely to be used by Sherborn residents, based on convenience of access, would be Medfield Junction, in Zone 4. The survey found that 41% of Sherborn residents using commuter rail boarded at West Natick or Natick, both in Zone 4. (This proportion has probably increased since 1993 because of the establishment of peak-period express service.) These riders would experience no difference in fares if they shifted to Medfield Junction. The next largest group, 38%, boarded at one of the stations in Wellesley, all in Zone 3. These passengers would pay more if they boarded at Medfield Junction. Another 12% boarded at Framingham Station in Zone 5, and would pay less at Medfield

Junction. The remaining 9% boarded at one of the Needham Line stations in Zone 2, and would pay more if they shifted to Medfield Junction.

The present through bus route from the Millis extension corridor to Boston offers a choice of one-way or ten-ride tickets. The one-way fare is \$4.00 from Millis, Medfield Dover, and the eastern half of Medway, or \$5.00 from West Medway. Ten-ride ticket prices vary more by boarding location, lowering the cost per ride to \$2.80 from Dover, \$3.00 from Medfield, \$3.20 from Millis, \$3.30 from Medway or \$3.40 from West Medway. There are no officially designated parking spaces for bus riders in any of these towns. There is only one stop in Dover, but there are five in Medfield and eight each in Millis and Medway.

Including parking costs, a monthly pass rider boarding at a station on a Millis extension would save between 22 and 35 cents per one-way trip compared with the ten-ride bus fare from the stop nearest the station. Relatively few Millis extension service area residents currently use the buses, however.

Table 3-2
Cost per One-Way Trip to Boston for Selected Rail and Bus Fare Options

<u>Alternative</u>	<u>Origin Town</u>			<u>Medfield</u>			<u>Dover</u>		
	<u>One-Way</u>	<u>12-Ride</u>	<u>Pass</u>	<u>One-Way</u>	<u>12-Ride</u>	<u>Pass</u>	<u>One-Way</u>	<u>12-Ride</u>	<u>Pass</u>
<u>Rail Extension Station</u>									
Millis (Clicquot)	\$3.25	\$2.71	\$2.48						
Medfield (Junction)				\$3.00	\$2.50	\$2.24			
Dover (Center)							\$2.50	\$2.08	\$1.95
<u>Existing Service</u>									
<u>Commuter Rail</u>									
Norfolk or Framingham	\$3.25	\$2.71	\$2.48						
Walpole, West Natick or Natick	\$3.00	\$2.50	\$2.24	\$3.00	\$2.50	\$2.24			
Norwood Central or Wellesley Sq.	\$2.50	\$2.08	\$1.95	\$2.50	\$2.08	\$1.95	\$2.50	\$2.08	\$1.95
Needham Jct., Hersey Dedham Corp. Ctr., or Rte. 128	\$2.25	\$1.88	\$1.71	\$2.25	\$1.88	\$1.71	\$2.25	\$1.88	\$1.71
Express Bus to Boston	\$4.00	\$3.20		\$4.00	\$3.00		\$4.00	\$2.80	

Notes: Costs shown above exclude parking fees.

Commuter rail passes provide free transfers to connecting MBTA services.

Multiple-ride fare comparisons for express bus are based on 10-ride tickets.

4. RIDERSHIP FORECASTS

Potential Commuter Rail Market Groups

Boston and Cambridge Work and Non-Work Trips

Based on the travel patterns on the existing Boston commuter rail system, the vast majority of riders on a Millis extension would use the service for peak-period work trips to Boston or Cambridge. On the commuter rail lines now terminating at South Station, 95 percent of all final trip destinations are in either Boston or Cambridge, and 89 percent of these are home-to-work trips. Otherwise stated, home-to-work trips ending in these two cities account for 85 percent of all South Side commuter rail ridership. Over 95 percent of the home-to-work trips on South Side commuter rail lines are made on A.M. peak trains, defined as those scheduled to arrive at South Station between 6:30 and 9:30.

For rail trips now originating in towns that would be served by a Millis extension, Boston and Cambridge work travel is even more predominant than in the figures above for total South Side rail ridership. In the 1993 survey, 100% of the respondents with origins in Medway, Millis, Medfield, Sherborn, or Dover reported final destinations in Boston or Cambridge and 94% were making home-to-work trips. Among the five towns, the proportion of home-to-work trips ranged from 90% to 98%.

Within Boston, the present commuter rail market share is highest for trips ending in Boston Proper, defined approximately as the area bounded by Massachusetts Avenue, the Charles River, Boston Harbor, Fort Point Channel, and the Southeast Expressway. The 1993 survey found that 90% of the Boston work trip destinations on South Side commuter rail lines were in Boston Proper. (Among Millis extension service area towns, the figure was 94%.) In contrast, 1990 Census figures showed that only about 55% of *total* Boston work trip destinations (all modes of travel) from the cities and towns served directly or indirectly by South Side rail lines were in Boston Proper. Rail work trip destinations to Boston locations outside Boston Proper were concentrated most heavily in neighborhoods bordering on Boston Proper, with 92% going either to the Fenway/Parker Hill area, South Boston, Charlestown or North Dorchester.

Other Destinations and Trip Purposes

Work trips account for a much higher proportion of commuter rail trips destined for Boston or Cambridge than of those destined for other locations. In the survey results, of the 5% of South Side rail trips with destinations outside Boston or Cambridge, only 40% (or 2% of the total ridership) were work trips.

Among South Side rail trips with destinations outside Boston or Cambridge, the vast majority involve traveling into Boston and transferring from commuter rail to other modes. Interzone ridership (i.e. trips between two stations on the same line excluding South Station, Back Bay, or stations in fare zone 1A or 1B) accounts for under 1% of weekday trips. This may, however, be more a reflection of the locations of rail stations

relative to suburban trip attractions than of inherent unattractiveness of commuter rail for suburb-to-suburb travel. As detailed in appendix G, interzone ridership possibilities specific to a Millis extension were analyzed, but it was concluded that interzone travel on this line would be only slightly over 1% of its total traffic.

A Millis extension could also serve some reverse-commuting trips, but based on the experience on existing Boston commuter rail lines, and on conditions specific to the Millis line, these would not be a significant ridership component. This is discussed further in appendix G.

Summary of Demand Estimation Method

Ridership forecasts for a Millis extension were prepared using a manual forecasting method described below and in appendix G. Separate forecasts prepared using the CTPS regional demand model showed lower ridership for every alternative, with the closest agreement occurring with express service. The manual forecast results were used in most of the analysis in this study, to show what the upper bound of possible ridership would be. (The model-based forecasts are discussed at the end of this chapter.) Total work travel from each town in the extension corridor to Boston Proper, the rest of Boston, and Cambridge was determined from U.S. Census Journey-to-Work reports. Estimates of the shares of this travel that a Millis extension could be expected to capture were made on the basis of information for existing commuter rail lines in the Census reports and in the 1993 MBTA commuter rail survey.

Non-work travel to Boston and Cambridge destinations via a Millis extension was estimated by adding factors derived from survey results to the work trip estimates. Ridership to destinations outside Boston and Cambridge was likewise estimated by applying factors to Boston and Cambridge ridership.

The Journey-to-Work figures used in making the ridership forecasts described above were taken from the 1990 Census. Estimates prepared by the Census Bureau and by the Metropolitan Area Planning Council (MAPC) indicate that overall population in the Millis extension service area increased by about 10% between 1990 and 1996. As a result of economic conditions, however, overall Boston and Cambridge employment was essentially the same in 1996 as in 1990. Since work trips to Boston and Cambridge would be the predominant source of ridership on a Millis extension, it was concluded that forecasts based on 1996 conditions would not differ significantly from those using the 1990 data. Ridership projections for the year 2020 were made using factors based on a combination of data from the Census Bureau, MAPC, and the Massachusetts Institute of Social and Economic Research.

Ridership Forecasts by Trip Purpose and Destination

Ridership forecasts using the methods discussed above were prepared for three different operating configurations, depicted in the diagrams on pages 16 and 17. In the Local Service configuration, Millis trains would run through to Boston and would stop

at all Needham Line stations from Needham Junction through Forest Hills. In the Express/Local configuration Millis trains would also run through to Boston, but during weekday peak hours they would run non-stop between Hersey Station and Ruggles. The number of Needham Heights trains would be the same as at present with either of these configurations.

In the third configuration, Combined Trains, cars from Millis and Needham Heights would be run in the same trains between Needham Junction and Boston, with the same service frequency as currently operated from Needham Heights. Further details on how this would be accomplished appear in chapter 7.

Ridership for Shuttle Service alternatives (depicted in the diagrams on pages 17 and 18) was not calculated by the manual method, but would be expected to be lower than that of Combined Trains. With Shuttle Service there could either be through trains from Needham Heights to Boston connecting at Needham Junction with shuttle trains from the Millis Line or through trains from the Millis Line connecting with shuttle trains from Needham Heights. The added inconvenience of transferring at Needham Junction would be a deterrent to ridership on the shuttle trains. (Forecasts from the Regional Model, discussed at the end of this chapter, show very large ridership losses for Shuttle Service to either terminal compared with through service.)

At current travel levels, the Local Service Millis extension alternative would serve an estimated 435 weekday inbound boardings at Millis, 510 at Medfield Junction, and 265 at Dover, for a combined total of 1,210. Of these, about 1,020 would be work trips to destinations in Boston or Cambridge, 125 would be non-work trips to Boston or Cambridge, and 65 would be trips to other destinations for all purposes. With ridership growth in proportion to projected population growth in the service area, boardings at extension stations would increase to 1,545 in the year 2020. (The totals above do not include passengers carried between pairs of stations on the present Needham Line by Millis trains. Such ridership is discussed later in this chapter.)

At current travel levels, the Express/Local Service Millis extension alternative would serve an estimated 465 weekday inbound boardings at Millis, 595 at Medfield Junction, and 300 at Dover, or a combined total of 1,360. (Much of the increase at Medfield Junction for Express/Local Service compared with Local Service is a result of the much greater attractiveness of Express service for Sherborn residents.) Of the total Express trips, about 1,145 would be work trips to destinations in Boston or Cambridge, 140 would be non-work trips to Boston or Cambridge, and 75 would be trips to other destinations for all purposes. Of the latter, only about 15 would be interzone trips to stations on the Millis or Needham lines; the rest would be trips through Boston or Cambridge to points not served directly by Millis trains. With ridership growth in proportion to projected population growth, boardings at extension stations would increase to 1,735 in the year 2020.

Under the Combined Trains alternative, ridership would be slightly lower than under the Local Service alternative because of added time for coupling and uncoupling train

sections at Needham Junction. Based on travel time elasticity, boardings at present travel levels would be 415 at Millis, 485 at Medfield Junction, and 250 at Dover, making a total of 1,150. This would increase to 1,470 in the year 2020.

Estimated Ridership by Town of Origin

Tables 4-1 and 4-2 show the outer endpoints of trips in the demand estimates at 1996 travel levels and in the year 2020. Combined population in the four towns in the extension service area is projected to increase by about 30% between 1990 (the year of the most recent U.S. Census) and 2020. Individual gains are expected to range from 17% in Millis to 46% in Medway.

Table 4-1
Estimated Weekday Inbound Ridership on Millis Extension
by Town of Origin at 1996 Travel Levels

<u>Town</u>	<u>All Local</u>	<u>Express/Local</u>	<u>Combined Trains</u>
Medway	175	180	165
Millis	260	285	250
Medfield	500	555	475
Sherborn	10	40	10
Dover	<u>265</u>	<u>300</u>	<u>250</u>
Total	1,210	1,360	1,150

Table 4-2
Estimated Weekday Inbound Ridership on Millis Extension
by Town of Origin in Year 2020

<u>Town</u>	<u>All Local</u>	<u>Express/Local</u>	<u>Combined Trains</u>
Medway	255	265	245
Millis	305	335	295
Medfield	620	685	585
Sherborn	10	50	10
Dover	<u>355</u>	<u>400</u>	<u>335</u>
Total	1,545	1,735	1,470

Estimated Diversions of Ridership from Other Transit Services

Table 4-3 on page 30 summarizes the ridership figures discussed in this section and the following one. Currently, about 785 residents of towns that would be in the service area of a Millis extension use MBTA commuter rail for all trip purposes combined on weekdays. About 90 other residents of the area use MBTA rapid transit or express bus service. An estimated 15 service area residents use private-carrier buses. Current

transit users would be among the most likely travelers to shift to a Millis extension, except that the majority of transit users from Sherborn would still find other alternatives more convenient. With maximum transit diversions, only 425 of the 1,210 riders with Local service, 545 of the 1,360 with Express/Local service, or 365 of the 1,150 with Combined Trains would be new transit users. (In the year 2020 new ridership for the same three service options would increase to about 535 with Local service, 725 with Express/Local service, or 455 with combined service.)

At present, the Franklin Line serves the largest share of commuter rail riders with trip origins in towns that would be served by a Millis extension. If express service were implemented on the Franklin Line with no Millis extension, it would attract about 35 of the same new riders predicted above for the Millis extension.⁷ If the base case for comparison is assumed to be a Franklin Line with express service instead of the present service pattern, then new ridership for each Millis extension alternative decreases by 35 per day at 1996 travel levels or by 45 per day at year 2020 travel levels compared with the estimates in Table 4-3. The service area of a Milford extension, if implemented, would not overlap that of a Millis extension. Therefore, the only impacts of a Milford extension on Millis extension ridership estimates would be those of associated service changes at present Franklin Line stations. (For Milford service with peak express trains, the changes would be the same as those for Franklin Line express service. For Milford all-local service, there would be no changes at present Franklin Line stations.)

Other Ridership Impacts on Present Commuter Rail Lines

Impacts of Diversions of Parked Cars

Most riders who would be diverted to a Millis extension from other MBTA services access their present boarding stations by driving and parking. Such diversions would leave more parking capacity available at existing stations. This could attract new transit users to stations where peak daily parking utilization is equal to or close to capacity, and where diversions to the extension would make a perceptible difference. The stations most affected by diversions to the extension would be Walpole, Norfolk, Dedham Corporate Center, Needham Junction, and Wellesley Square, where 75% of the commuter rail riders from the extension service area now board. Based on the most recent information on parking capacity and utilization (including privately-owned lots used by commuters) and on planned additional parking capacity, only Needham Junction and Wellesley Square are so close to capacity that cars parked by riders originating in the extension area would be a deterrent to ridership from other origins.

The 1993 survey found that a total of 122 passengers with trip origins in Millis, Medfield, Sherborn, or Dover boarded at Needham Junction, and that 105 of them drove or rode in cars parked at or near the station. This is the maximum number of new

⁷Express service for the Franklin Line both with and without an extension to Milford is analyzed in the CTPS Milford Commuter Rail Extension Feasibility Study, also conducted in 1997.

riders that would be attracted to Needham Junction as the result of parking capacity freed up by diversions to the extension.

At Wellesley Square, 63 boardings were by passengers originating in the Millis extension service area, including 60 who drove or rode in parked cars. This is the maximum number of new riders that would be attracted to Wellesley Square as the result of parking capacity freed up by diversions to an extension with express service. Without express service on the Millis Line, Sherborn residents who board at Wellesley Square would not be diverted, so only parking spaces used by 31 passengers from other towns in the extension service area would be freed up there.

Impacts of Millis Train Service at Present Needham Line Stations

The impact of Millis service on ridership at present Needham Line stations would depend on the particular operating strategy adopted. Under the Local Service Millis alternative, all stations from Needham Junction through Forest Hills would get twice as much service as at present. Based on headway elasticity models, this would attract about 370 additional A.M. peak inbound riders to those stations from towns outside the service area of a Millis extension. During off-peak hours, when ridership is relatively low, doubling service would attract a total of only about 50 additional riders. Of the total 420 additional boardings, 160 would take place at stations in Needham and 260 at stations in West Roxbury.

Trips originating in Needham that are not currently made by commuter rail are made predominantly by auto, so most of the 160 new rail boardings at Needham Junction or Hersey would represent new transit users. For trips originating in the West Roxbury segment of the line, alternative transit service is provided by several local MBTA bus routes to the Orange Line at Forest Hills. It is likely that at least half of the new commuter rail boardings in that segment, or about 130, would be diverted from these services. Therefore, the maximum number of new transit users on the present Needham Line including impacts of freed-up parking as well as those of improved service would be 395. Parking capacities at some of the stations would need to be expanded if ridership were to increase as much as the potential added demand.

Under the Express/Local Millis alternative, Needham Junction and Hersey would receive significantly faster travel times in peak hours. The combined impact of the faster service and increased frequency would attract about 270 additional A.M. peak riders to those two stations from towns outside the service area of a Millis extension. Most of these would be new transit users. Other stations on the line would have no change in peak service, but all stations from Needham Junction through Forest Hills would have service doubled during off-peak hours. As in the case of local service all day, this would attract about 50 additional off-peak riders. These would include about 35 new transit users and 15 diversions from existing service.

The service-related increases in ridership at existing stations could be attained without a Millis extension by operating additional trains between Needham Junction and Boston

on the same schedules assumed for Millis trains. Riders from the extension corridor who board at Needham Line stations would still board there, so there would not be any component of new ridership attracted by freed-up parking capacity. Doubling the number of peak-period local trains would also attract about 25 additional riders to Needham Junction and Hersey from towns in the Millis extension corridor. Operating peak-period express trains from Needham Junction would attract about 50 new riders to Needham Junction and Hersey from Millis extension corridor towns. With extra service running through to Needham Heights, an additional 70 A.M. peak boardings at Needham Heights and Needham Center would be expected if the extra trains made all stops, or an additional 125 if the extra trains ran non-stop from Hersey to Ruggles. Attainment of all of these increased ridership levels would require provision of sufficient parking, however.

The service area of the Needham Line (excluding towns that would be served by a Millis extension) is expected to have relatively low population growth between 1990 and 2020. Therefore, the number of new riders attracted to present Needham Line stations as a result of increased frequency or express service provided by Millis Line trains would be less than 10% greater in the year 2020 than under present conditions. In absolute terms, this would be a difference of 30 or fewer inbound riders per day.

Under the Combined Trains alternative, there would be no change in service at any stations between Needham Junction and Forest Hills, and hence no ridership impacts there other than that of freed-up parking at Needham Junction. Travel times from Needham Heights and Needham Center would increase, however, because of the time required to couple and uncouple cars. This would be expected to cause a loss of about 30 boardings per day at these stations. This would reduce the net gain in new riders at Needham Branch stations to about 75.

If through service to Boston were operated only from Millis or Needham Heights with service from one of the two being provided by shuttle trains to Needham Junction, travel times to Boston from the branch with through service would be the same as under the Local Service option. Times from the branch with connecting service would be about the same as under the Combined Trains option, but the added inconvenience of transferring would make the service less attractive. Therefore, ridership with connecting service would be lower than that with Combined Trains.

Table 4-3 summarizes estimated new and diverted ridership on a Millis extension for Local, Express/Local, and Combined Millis and Needham Heights trains at 1996 travel levels and in the year 2020.

Estimated Weekend Ridership

Weekend ridership is more difficult to predict than weekday ridership, because weekend travel consists largely of non-repetitive trips for purposes such as shopping, sightseeing, attending sporting events, etc. For the commuter rail system as a whole, 1994 data showed that ridership averaged 29.2% as high on Saturdays as on weekdays,

Table 4-3
Estimated Weekday Inbound Ridership on Millis Extension
and New Ridership on Needham Line
(1996 and 2020)

<u>Ridership Category</u>	<u>All Local</u>		<u>Express/Local</u>		<u>Combined Trains</u>	
	<u>1996</u>	<u>2020</u>	<u>1996</u>	<u>2020</u>	<u>1996</u>	<u>2020</u>
Extension Stations						
New Transit Riders	425	535	545	685	365	455
Diverted Transit Riders	<u>785</u>	<u>1,010</u>	<u>815</u>	<u>1,050</u>	<u>785</u>	<u>1,015</u>
Total Inbound Boardings*	1,210	1,545	1,360	1,735	1,150	1,470
Present Needham Line Stations						
New Transit Riders	395	425	410	440	75	80
Diverted Transit Riders	<u>130</u>	<u>140</u>	<u>15</u>	<u>15</u>	0	0
Total Additional Boardings	525	565	425	455	75	80
New Transit Riders at Wellesley Square Station	30	30	60	60	30	30
Total New Transit Riders	850	990	1,015	1,185	470	565

* Boardings at extension stations by town of origin appear in Tables 4-1 and 4-2

and 17% as high on Sundays as on weekdays. With ratios similar to these and weekday ridership at the 1996 travel levels estimated in Table 4-1, stations on a Millis extension would be expected to serve between 335 and 400 riders on Saturdays. If Sunday service were operated, ridership at 1996 travel levels would be expected to range between 195 and 230. If weekend Millis trains stopped at all Needham Line stations from Needham Junction to Boston and Needham Heights service were retained as well, the additional frequency would be expected to increase boardings at the shared stations by about 125 per Saturday

At present, there is no Sunday service on the Needham Line. Experimental Sunday service run on the line in 1992-93 attracted fewer than 100 riders each way per day. With Sunday boardings in typical proportion to weekday ridership, Sunday Millis trains would be expected to attract 200 to 250 boardings at stations from Needham Junction through Forest Hills

Model-Based Ridership Forecast

In addition to the demand estimates produced by the methods described above and in appendix G, ridership on a Millis extension was forecast using the CTPS Interim Regional Model. This model is currently being used for all CTPS highway and transit studies within the region. The Regional Model forecasts were made for the year 2000. When adjusted to the same year, the manual forecasts for overall ridership on a Millis extension with either peak-period express service or local service at all times are higher

than those produced by the Regional Model, with the discrepancy being greater for local service.

Comparisons of the results of the two methods are set forth in greater detail below, and are summarized in Table 4-4. These comparisons indicate that ridership on a Millis extension is unlikely to be higher than the manual forecasts, which were used as the basis for the cost-effectiveness measures in subsequent chapters this report. Therefore, cost effectiveness would be no better, and could be significantly worse, than indicated.

Extension with Peak-Period Express Service

For a Millis extension with peak-period express service, the Regional Model predicted that in the year 2000 there would be 530 weekday boardings at Millis, 480 at Medfield Junction, and 380 at Dover, for a combined total of 1,390. The manual forecasts discussed in other sections of this study are for 1996 travel levels and for the year 2020. With adjustments to the year 2000 based on predicted population changes, the manual method would predict 530 boardings at Millis, 650 at Medfield Junction, and 340 at Dover, for a combined total of 1,520. This is 9% more boardings than predicted by the Regional Model, or an absolute difference of 130. The discrepancy is all at the two innermost stations, with the Regional Model predicting 12% more boardings at Dover, but 26% fewer boardings at Medfield Junction. This is partly a result of differences in assumed boarding locations of residents of Sherborn and of the northern section of Medfield.

The manual forecasts indicated that of the year 2000 boardings on the extension, 605 would be new transit users. In addition, it was estimated that as a result of Millis express service about 485 new transit users would be attracted to existing commuter rail stations, making a grand total of 1,090 new users. In contrast, the Regional Model predicted a total of only 650 new inbound transit riders per day. This figure was not broken down by boarding station. Based on present transit use by residents of the extension service area, the boardings predicted for the extension stations would have to include at least 565 new transit riders, leaving at most 75 new riders at present stations. This implies that among riders attracted to existing commuter rail stations as a result of Millis express service, the proportion accounted for by diversions from other transit services would be much higher than assumed in the manual forecasts. This would also mean that new transit revenue resulting from the extension would be significantly lower than predicted by the manual forecasts.

Extension with Local Service Only

For a Millis extension with local service at all times, the Regional Model predicted that in the year 2000 there would be 300 weekday boardings at Millis, 250 at Medfield Junction, and 220 at Dover, for a combined total of 770. With adjustments to the year 2000 based on predicted population changes, the manual method would predict 495 boardings at Millis, 555 at Medfield Junction, and 305 at Dover, for a combined total of

1,355. This is 76% more boardings than predicted by the Regional Model, or an absolute difference of 585.

Of the 1,355 boardings predicted by the manual method, 470 would be new transit users. In addition, it was predicted that the local service would attract about 440 new transit riders to existing commuter rail stations, making a total of 910 new transit riders. The Regional Model predicted a total of only 350 new inbound transit riders for this alternative, again with no breakdown by boarding location.

The manual forecast results for the local service alternative were produced by applying travel time elasticity factors to the increases in running times for local versus express service, but did not fully analyze the reduced competitiveness of the local service with other transit alternatives or with auto travel. The Regional Model attached much more weight to comparative travel times of the local service with other alternatives.

The results of both methods indicate that the alternative with express service during peak periods would attract more total riders and more new transit riders than that with local service at all times.

Extension with Combined Millis and Needham Heights Trains

In addition to the local and express service alternatives with through service to Boston, the manual forecasts included an alternative in which Needham Heights and Millis trains would be combined between Needham Junction and South Station. The Regional Model forecasts did not include this alternative, but instead included two transfer service alternatives. In one of these, Needham Heights trains would be run through to Boston as at present, with connecting trains running between Needham Junction and Millis. In the other transfer alternative, Millis trains would run through to Boston and connecting trains would be run between Needham Junction and Needham Heights. Schedules were assumed to be arranged to provide close connections between through and connecting trains, but with added travel times of about 5 minutes for transfer passengers compared with through service.

The model predicted that requiring transfers would have a significant negative impact on ridership. With Millis trains running to Needham Junction only, boardings on the extension were predicted to total only 210 per day, or a decrease of 560 compared with the ridership predicted by the Model for the local service alternative. With through service from Millis and connecting service from Needham Heights, boardings at Needham Heights and Needham Center were predicted to drop from 325 per day under the local service alternative to 100 per day, or a decrease of 225.

As discussed in chapter 7, operating combined Needham Heights and Millis trains east of Needham Junction would be expected to increase travel times to Boston from points served by the separate trains by at least 7 minutes compared with through local service. No passengers would have to transfer at Needham Junction, however. Because of the importance of travel time in the Regional Model forecasts, it would be expected that

ridership predictions for the combined service alternative produced by the model would be lower than those for the all-local service alternative. Stations from Needham Junction east would be expected to show no changes in ridership from the base case, because neither service frequency nor travel times at these stations would change.

Table 4-4
Comparisons of Weekday Inbound
Ridership Estimates for Millis Extension
from Manual Method and from Regional Model
for Year 2000

	<u>Peak Express/ Off-Peak Local</u>		<u>Local Only</u>	
	<u>Manual</u>	<u>Model</u>	<u>Manual</u>	<u>Model</u>
Millis	530	530	495	300
Medfield Junction	650	480	555	250
Dover	<u>340</u>	<u>380</u>	<u>305</u>	<u>220</u>
Total Extension	1,520	1,390	1,355	770
New Transit Riders on Extension	605	Not calculated separately	470	Not calculated separately
New Transit Riders on Existing Lines	485	Not calculated separately	440	Not calculated separately
Total New Transit Riders	1,090	650	910	350

5. CAPITAL COSTS

The main capital costs for commuter rail extensions consist of construction or upgrading of tracks, signals, bridges, and crossings, construction of station and parking facilities and train layover facilities, and acquisition of rolling stock. A Millis extension terminating at Clicquot would use a rail line that is mostly still used for freight service. A segment of about one third of a mile at Medfield Junction has been dismantled. The track that is still in use is in poor condition and would need to be entirely rebuilt to make it suitable for passenger service. Capital costs are summarized below and in Table 5-1 by category. (Additional costs for extensions terminating at Route 109 in Millis or at West Medway are discussed in appendixes E and F.) All of the capital cost figures presented in this study are approximations. In general, the unit costs used were the same as those in the 1997 New Bedford/Fall River Commuter Rail Expanded Alternatives Analysis. Costs for items not directly comparable to any in that analysis were based on earlier MBTA commuter rail studies, with adjustments for inflation to 1997.

Track and Signals

As noted above, a Millis extension would require reconstruction of the existing track as well as replacement of track on short segments where there is none now. The line between Needham Junction and Millis is unsignalized, so a completely new signal system would be needed for passenger service.

Costs for track and signals are related directly to route length. The distance from Needham Junction to Clicquot is 9.5 miles. Track replacement and signal installation for this distance would cost \$26,970,000. An extension to any Millis terminal would require re-installation of the diamond crossing between the Millis Line and the Conrail Framingham Secondary Track at Medfield Junction. Including interlocking signals to protect the crossing, this would cost about \$1,525,000.

The Millis Line has always been entirely a single-track route. The only existing passing siding on the line now is at Clicquot. Additional passing sidings would not necessarily be required for future service, but would allow more flexibility in scheduling. The 1988 study concluded that an extension terminating in Millis would need one passing siding in Dover. For purposes of cost calculation, the present study assumes that the extension would include one 2,000-foot passing siding. Including track work, switches and interlocked signals, each such siding would cost about \$3,650,000 in addition to the costs stated above.

Road Crossing Surface, Lights, and Gates

Between Needham Junction Station and the Clicquot station site in Millis, the Millis extension route has 10 grade crossings of public roads and at least 8 crossings of private roads. (About half of the latter are farm crossings; the remainder provide access to gravel pits and municipal sewage treatment plants.) Six of the public crossings were

formerly protected by automatic flashing lights without gates, but none of the lights now function. The remainder of the public crossings and all of the private crossings have apparently always been protected at most by warning signs or manual flagging of traffic by train crews.

The public crossing surfaces generally consist of asphalt pavement, with timbers next to the rails. These surfaces are in fair to poor condition. For passenger service, all of the public crossings should be rebuilt with rubberized surfaces, and automatic flashing lights and gates should be installed. For an extension terminating at Clicquot, the cost of these improvements would be \$2,060,000.

Fencing

At present, most of the right-of-way of the Millis Line is unfenced. For safety, fencing would be needed at all locations where developed land adjoins the rail line. A preliminary inspection indicates that an extension as far as Clicquot would require about 13,000 linear feet of fencing, at a cost of about \$85,000.

Bridges

Between Needham Junction and Millis the only bridge over a road is at Chestnut Street, just west of Needham Junction Station. This bridge was rebuilt in conjunction with the reconstruction of the Needham Line in the 1980s and would require no additional upgrading for passenger service. The rail line makes two crossings of the Charles River on open-deck wooden pile trestles. One of these, on the border of Needham and Dover, is 135 feet long. The other, on the border of Medfield and Millis, is 180 feet long. These are in fair condition. They are adequate for the current light-density freight traffic on the line, but would need to be replaced for frequent passenger service with higher train speeds. The dismantled track segment near Medfield Junction Station crossed Mill Brook, on a 20-foot-long open-deck bridge of steel I-beams. Because of its deteriorated condition, this bridge would need to be replaced for passenger service. The cost of replacing the three bridges would be about \$4,315,000.

Three roads cross the rail line on bridges between Needham Junction and Clicquot. Passenger service would not require any improvements to these bridges that would not otherwise be needed to maintain the existing freight service on the line, so no cost for upgrading these bridges has been included.

Station Platforms and Shelters

Stations on a Millis extension would all be either at locations where there were never stations in the past or at locations where no usable components of past stations remain. Therefore, all-new construction would be needed at each site. The current standard for new MBTA commuter rail stations is eight-car high-level platforms. Although ridership at stations on either extension alignment alone would not require eight-car trains, Millis trains would also serve some stations on the Needham Line. In addition, for scheduling

efficiency, it is desirable to allow equipment sets to shift between routes at South Station. For these reasons, it is assumed that Millis extension stations would have eight-car high-level platforms. Recent construction costs for such platforms for the Old Colony lines, including benches, shelters, and lighting but excluding land acquisition averaged \$1,200,000 per station. Regardless of specific station sites, a Millis extension would have one station each in Dover, Medfield, and Millis. At the same average cost as the Old Colony stations, the three stations would cost \$3,600,000.

Parking

The required parking capacity on a Millis extension would depend on the service operating strategy and the general station locations. Because of the proximity of the Millis extension corridor to existing rail corridors on either side, a Dover station would be used mostly by Dover residents. A Medfield station would be used mostly by Medfield or Sherborn residents. A Millis station would be used mostly by residents of Millis and Medway. At the ridership forecast with 1996 travel levels, if all Millis line trains ran in local service on the Needham Line, required parking capacity would be 320 at Millis, 270 at Medfield, and 140 at Dover. Additional riders attracted to present Needham Line stations by the increased service frequency would require a total of 140 additional spaces at these stations. This would make a total of 870 spaces needed at new or existing stations.

With express service during peak hours, parking capacity requirements would increase to 340 at Millis, 330 at Medfield, and 155 at Dover. Fewer new riders would be attracted to the existing Needham Line by the express alternative however, because only Needham Junction and Hersey would have improved service in peak hours. These riders would require 115 additional spaces at existing stations. This would make a total of 940 spaces needed at new or existing stations.

With Millis and Needham Heights trains combined between Needham Junction and Boston ("Combined Service"), required parking capacity on the extension would decrease to 300 at Millis, 260 at Medfield, and 130 at Dover, or a total of 690 spaces. No expansion of parking would be needed on the present Needham Line, since the only new riders attracted there would be those using parking spaces vacated by passengers diverted to the extension.

Assuming surface parking, the cost of constructing 870 new spaces would be \$3,655,000. The cost for 940 new spaces would be \$3,950,000. The cost for 690 new spaces would be \$2,900,000. Land acquisition costs for parking would depend on the specific sites selected and their present uses and appraised values. Based on recent experience, the total cost of parking land acquisition for the Local and Express/Local alternatives would be around \$2,000,000. For the Combined Service, alternative land this would decrease to about \$1,500,000.

With the ridership increases predicted by the year 2020, parking capacity for the Local or Combined Service alternatives would need to be expanded by an additional 110

spaces at Millis, 60 spaces at Medfield, and 45 spaces at Dover. For the Express/Local alternative, the required parking expansion would be 115 spaces at Millis, 80 at Medfield, and 50 at Dover. Compared with requirements at 1996 travel levels, the additional 215 spaces needed by 2020 for Local Service would increase parking construction cost to \$4,555,000. For the Express alternative, the additional 245 spaces needed by 2020 would increase parking construction cost to \$4,975,000. For combined service, parking construction cost would increase to \$3,800,000. (Some construction economies might be achieved by building parking lots to maximum capacity from the outset, but normal wear-and-tear and weathering would require replacement of the original parking surfaces by 2020.)

Layover Facility

As discussed in chapter 3, the extension should include a layover facility to minimize operation of non-revenue train-miles. The cost of a facility of the size needed for a Millis extension would be about \$2,270,000.

Rolling Stock

Rolling stock requirements for a Millis extension would depend on the number of trips operated each day, the location of the outer terminal, the strategy used for coordinating Millis service with existing Needham Line service, and the kind of equipment used. Chapter 6 discusses operating costs for several alternatives using push-pull trains similar to those now used throughout the MBTA commuter rail system and for other alternatives using trains of Diesel Multiple-Unit (DMU) cars. Rolling stock costs attributable to the extension would include acquisition of equipment that would be needed to operate the commuter rail system with the extension but would not be needed without it. Locomotives now cost about \$2,000,000 each and double-deck coaches about \$1,800,000 each. The 1997 New Bedford/Fall River Analysis used an estimated cost of \$2,500,000 each for DMU cars. This could vary depending on the specific car model selected, and the extent to which standard equipment versus custom design was relied on.

With running times as estimated in chapter 3, peak-period service with five departures (the same as now operated from Needham Heights) using push-pull trains would require four train sets, each with one locomotive. Including adjustments for all ridership impacts discussed in chapter 4, Needham Line service operated together with Millis extension all-local service would require a capacity increase equivalent to that of seven double-deck coaches when compared with Needham Line service alone. Because of diversions from the Franklin Line, one coach could be reassigned to the Millis Line from that route, reducing the net coach acquisition requirement to six. Expected ridership growth between 1996 and 2020 would raise the added capacity requirement to eight coaches.

To allow interchangeability of train sets among assignments, present policy is to include at least six coaches in each train set used on the South Side.⁸ This would require a total of 24 coaches for the four Millis Line train sets of which three could be shifted from present trains and 21 would need to be acquired. This requirement would supersede the capacity requirement for either year 1996 or year 2020 ridership. The cost of four locomotives and 21 double-deck coaches would be \$45,800,000.

Peak-period express service, would attract more riders to the extension itself than all-local service but fewer new riders to the existing Needham Line. Compared with present service, the required increase in capacity would be equivalent to that of eight double-deck coaches. Ridership growth from 1996 to 2020 would require further capacity expansion of two coaches. The six-car-per-train minimum would again supersede capacity requirements, so the rolling stock cost would be the same as for the local service alternative.

With Millis trains all combined with Needham Heights trains between Needham Junction and Boston, but still using push-pull equipment, Millis trains would still require four locomotives. Because of the smaller net increase in ridership, only five more double-deck coaches would be required for the combined service than for Needham Heights service alone at 1996 ridership levels. For operational reasons discussed in chapter 7, the equipment sets used in this service would need to be kept separate from those used on other South Side lines during peak hours, requiring acquisition of one more locomotive and six more coaches than indicated by the capacity calculations above. The latter requirement would still supersede the capacity requirement by the year 2020. The cost of five locomotives and 11 double-deck coaches would be \$29,800,000.

As discussed in chapter 6 and appendix D, operation of combined Millis and Needham Heights trains with DMU cars would require substitution of DMUs for push-pull equipment on all Needham Heights trains. Assuming that the DMUs would be single-level cars with 120 seats each, at 1996 ridership levels the combined service would require 28 cars for weekday peak schedules, plus 3 spares to allow down-time for maintenance. At \$2.5 million per car, this fleet would cost \$77,500,000. This expense would be partly offset by the reassignment of push-pull trains from the Needham Line to other routes, avoiding the need for more new cars on those routes. Present peak-period Needham Line service includes five trips, using four equipment sets. Taking into account sharing of equipment with other routes, substitution of DMUs for push-pull trains on all Needham Line trips would effectively free up three locomotives and 19 coaches for use on other lines. This would avoid the need for equipment acquisition expenses of \$40,200,000 for those routes, resulting in a net expense of \$37,300,000 for equipping the Needham and Millis Lines with DMUs. Ridership growth from 1996 to 2020 would require an additional three DMUs, raising the expense to \$44,800,000.

⁸One set used almost exclusively on the short Fairmount Line normally has only five cars.

Summary of Capital Costs

The capital costs discussed above for a Millis extension with a Clicquot terminal are summarized in Table 5-1. (These include costs for parking facilities and rolling stock sufficient for estimated year 2020 ridership.) Estimated capital costs for an extension with local service only would total \$111,495,000. Capital costs with peak-period express service would total \$112,010,000, with the increase compared with local service resulting from the net extra parking capacity needed for additional express riders.

If Millis and Needham Heights trains were combined between Needham Junction and Boston using push-pull equipment, capital costs would total \$93,095,000. Using DMUs instead of push-pull equipment would raise this cost to \$108,995,000.

Capital Costs Relative to New Transit Ridership

Capital cost per new transit rider is one measure commonly used in evaluating proposed transit projects. Estimates of total ridership and new transit ridership for the Millis extension alternatives are discussed in chapter 4. Capital costs per new transit rider for these alternatives are shown in Table 5-1 and discussed below. These costs are expressed in terms of new inbound riders, because most individuals using MBTA commuter rail make one inbound trip and one outbound trip each day that they use the system. The ridership figures used are projections for the year 2020, for consistency with other extension studies. Ratios for earlier years would be higher. In the 1994 PMT, the number of new transit trips shown for each project was the combined total of new riders in both directions. For comparison with the ratios in Table 5-1, the PMT costs per new rider must be doubled.

Of the alternatives shown in Table 5-1, an extension with peak-period express service would have the lowest capital cost per new transit rider, at \$94,523. With local service at all times, the cost would be 19% higher than this, at \$112,621.

Alternatives in which Millis and Needham Heights trains would be combined east of Needham Junction would have much higher costs per new rider. Compared with the Express/Local alternative, Combined trains using push-pull equipment would reduce capital costs by at most 17% but would attract only about half as many new riders.

For comparison, the most recent estimate of capital cost per new transit rider in the year 2020 for the Worcester extension is \$45,732. For the Newburyport extension, the figure is \$93,055. Both of these projects are currently under construction.

About one third of the new riders attracted by the Local Service and Express/Local service alternatives for a Millis extension would consist of passengers attracted to stations on the present Needham Line by increased train frequency or faster travel times. The same service improvements could be achieved with no extension by adding more Needham Line trains originating at Needham Junction. The associated capital costs of such added service would be slightly more than one third those of the extension

alternatives, or about \$41 million for either local service at all times or peak-period express and off-peak local service. The capital cost per new transit rider would be \$106,338 with peak-period express service or \$118,667 with expanded peak-period local service.

Table 5-1
Summary of Capital Costs for Millis Extension

<u>Item</u>	<u>Amount</u>
<u>Local Service - Fixed Facilities</u>	
Track, Signals, and Passing Sidings	\$32,145,000
Grade Crossing Surface, Lights, Gates	2,060,000
Fencing	85,000
Bridges	4,315,000
Station Platforms and Shelters	3,600,000
Parking (including land acquisition)	6,555,000
Layover Facility	2,270,000
Contingencies	4,905,000
Engineering, Administration & Inspection	<u>7,010,000</u>
Subtotal	\$62,945,000
<u>Local Service - Rolling Stock</u>	
Locomotives and Coaches	\$45,800,000
Engineering, Administration & Inspection	<u>2,750,000</u>
Subtotal	\$48,550,000
Total Capital Cost for Local Service	\$111,495,000
Capital Cost per New Transit Rider (2020)	\$112,621
Total Capital Cost for Express/Local Service	\$112,010,000
Capital Cost per New Transit Rider (2020)	\$94,523
Total Capital Cost for Combined Needham Heights and Millis Trains (push-pull)	\$93,095,000
Capital Cost per New Transit Rider (2020)	\$164,770
Total Capital Cost for Combined Needham Heights and Millis Trains (DMUs)	\$108,995,000
Capital Cost per New Transit Rider (2020)	\$192,912

*Notes: All costs are approximate; detailed engineering studies would be needed to refine costs.
Costs for parking and rolling stock are based on year 2020 capacity requirements.*

6. OPERATING COSTS AND REVENUES

Operating Costs

Operating costs for a Millis extension would depend on the number of trips operated each day, the location of the outer terminal, the strategy used for coordinating Millis service with existing Needham Line service, and the kind of rolling stock used. At present, all MBTA commuter rail service is provided by trains of locomotives and coaches running in push-pull configuration.⁹ Millis extension operating alternatives for which costs have been calculated below include some using push-pull trains and some using trains of Diesel Multiple-Unit (DMU) cars.

A Millis extension would be a branch off the Needham Line rather than a continuation beyond that line's present outer terminal. Unless the number of trains going to Needham Heights were reduced, or Millis and Needham Heights trains were combined east of Needham Junction, costs for Millis service would include expenses for operation between Needham Junction and Boston as well as on the extension itself. As a basis of comparison for the cost estimates below, the annual operating cost of present Needham Line service calculated by the same formula is \$4,990,000.

Costs with Millis Push-Pull Trains Running Through to Boston Separately

With the same frequency of service as now operated on the Needham Line on weekdays (16 round trips) and Saturdays (9 round trips), no change in the number of Needham Heights trains, and use of push-pull equipment, the annual operating cost for a Millis extension to Clicquot would be \$7,730,000. This cost would apply either with local service at all times or with express service in weekday peak hours and local service in off-peak hours. At present, the Needham Line has no Sunday service. If such service were operated on the Millis extension with the same frequency as Franklin Line Sunday service (7 round trips) the annual cost of this service would be \$680,000, bringing the annual total operating cost to \$8,410,000.

Costs with Millis and Needham Heights Trains Combined Between Needham Junction and Boston Using Push-Pull Equipment

For a train running through to Boston from the Clicquot station site in Millis, more than half of the train-miles (56%) would be on the existing Needham Line route between Needham Junction and South Station. Since operating cost varies directly with train-miles in the estimation formulas used in analyzing commuter rail extensions, the incremental costs for a Millis extension would be reduced by more than half if Millis Line passengers were carried in Needham Line trains on the shared route segment. This could be accomplished either by having Millis extension passengers transfer at

⁹ A train in push-pull configuration can be operated either from the locomotive (pull mode) or from an engineer's cab in the coach at the opposite end of the train (push mode).

Needham Junction or by having cars from the extension attached to Needham Heights trains between the Junction and Boston.

As discussed further in chapter 7, with push-pull equipment, delays for combining trains at Needham Junction would be minimized by coupling entire trains together rather than by shifting selected cars between trains. Train sets used in this service on any given day would be used exclusively on the Needham and Millis lines. Therefore, train lengths would be determined by the capacity needs of those lines alone rather than by any requirements for exchanging sets with other routes in Boston.

With no change in the number of Needham Heights trains, but with a Millis section added to each train, the increase in annual operating cost resulting from an extension to Clisquot would be \$2,855,000 compared with present service. This would be \$4,875,000 less than the cost estimated above for running Millis trains through to Boston separately.

With combined trains, the running time between Needham Junction and Boston for each train would be the same as that of the separate Needham Heights train it replaced. There would be no increase in service frequency at existing Needham Line stations, so the only new riders attracted to those stations would be those taking advantage of parking capacity freed up by riders diverting to extension stations. The percentage reductions in operating cost would be slightly greater than the reductions in train-miles, because the lower ridership would allow some reductions in the capacity provided.

Costs with Millis and Needham Heights Trains Combined Between Needham Junction and Boston Using DMU Equipment

Another option for operating combined Millis and Needham Heights trains would be to use self-propelled Diesel Multiple-Unit (DMU) equipment instead of push-pull trains. For reasons discussed in chapter 7, it would probably be necessary to run all Needham Line and Millis service with trains made up exclusively of DMUs rather than mixing DMUs with push-pull equipment. Operating costs for DMUs are uncertain because of lack of recent experience in the United States with cars similar to those that would be needed for Needham/Millis service. With the same unit costs assumed in an analysis of commuter rail service to New Bedford and Fall River recently completed for the MBTA,¹⁰ DMUs would reduce annual operating expenses for Needham/Millis service by about 20% compared with operating the same service with push-pull trains.

The cost of operating the present Needham Line alone with DMUs would be about 30% less than the operating cost with the present equipment (\$3,540,000 versus \$4,990,000). It would be equally feasible to convert the Needham Line to DMU operation with or without a Millis extension, so the incremental cost of the Millis DMU alternative should be compared with the cost of present service if run with DMUs. On that basis, with a

¹⁰See MBTA *New Bedford/Fall River Commuter Rail Project Expanded Alternatives Analysis*. March 1997

terminal at Clicquot the increase in annual operating cost for a Millis extension would be \$2,710,000.

Operating Revenues

Operating revenues were estimated for a Millis extension with local service through to Boston at all times, for express service in peak hours and local service in off-peak hours all running through to Boston, and for Millis trains running combined with Needham Heights trains east of Needham Junction. (The demand forecasting procedure was not sufficiently sensitive to distinguish between alternate locations for extension stations within individual towns.) Revenue calculations were based on the present fare structure. Ratios of Saturday and Sunday ridership and revenue to weekday totals were assumed to be similar to those for present MBTA commuter rail lines. The ridership estimates used in these calculations are those from the manual forecasting method, discussed in chapter 4, at 1996 travel levels. Revenue calculations based on the forecasts from the Regional Model would be lower.

For the Local Service Millis extension with service Monday through Saturday, annual fare revenue from passengers using extension stations would be \$1,590,000. Ridership would include diversions of passengers who currently account for \$945,000 of revenue on other MBTA services. Therefore, including only boardings on the extension itself, annual fare revenue for the MBTA system would increase by \$645,000. About 17% of the diversions would come from the Needham Junction or Wellesley Square stations, where parking facilities are now filled to capacity on a typical weekday. If all of the parking spaces freed up by diversions were refilled by new riders not diverted from other MBTA services, this would add \$135,000 in new revenue. The additional frequency provided by Millis trains at existing Needham Line stations would generate another \$320,000 per year in new revenue.

Including all ridership changes discussed above, a Local Service Millis extension with service Monday through Saturday would increase MBTA system revenue by \$1,100,000 per year. Sunday service would attract an additional \$45,000 in annual revenue. Operation of Millis service only on weekdays would reduce the annual revenue increase to \$1,025,000.

For the Express/Local Service Millis extension with service Monday through Saturday, annual fare revenue from passengers using extension stations would be \$1,785,000. Of this, \$810,000 would represent new MBTA system revenue. If all of the parking spaces at Needham Junction and Wellesley Square freed up by diversions to the extension were refilled by new system riders, this would add \$160,000 in revenue. New riders attracted to Hersey and Needham Junction by express service and to these and other stations by increased train frequency would generate another \$330,000 per year in new revenue.

Including all ridership changes discussed above, an Express/Local Service Millis extension with service Monday through Saturday would increase MBTA system

revenue by \$1,300,000 per year. Sunday service would attract an additional \$50,000 in annual revenue. Operation of Millis service only on weekdays would reduce the annual revenue increase to \$1,215,000.

With all Millis extension service provided by trains combined with Needham Heights trains between Needham Junction and South Station and service Monday through Saturday, annual fare revenue from passengers using extension stations would be \$1,515,000. Of this, \$570,000 would represent new MBTA system revenue. As under the Local service option, new riders attracted to Needham Junction or Wellesley Square by parking spaces vacated there would contribute another \$135,000 in new system revenue. There would, however, be a decrease of \$35,000 in revenue at Needham Heights and Needham Center as the result of increased travel times from there. There would be no other changes in Needham Line revenue. The net result of all of these changes would be an increase of \$670,000 in annual system revenue. Sunday service would attract an additional \$25,000 in annual revenue. Operation of Millis service only on weekdays would reduce the annual revenue increase to \$630,000.

Comparisons of Revenues and Operating Costs

Using calculation methods comparable to those used in this study for all Millis extension alternatives, the revenue-to-operating cost ratio for the MBTA commuter rail system as a whole in 1996 was about 42%. For the Needham Line alone, the ratio was about 50%. All of the Millis alternatives with through train service would have ratios much lower than these, as would combined Needham Heights and Millis trains. Results for the main alternatives examined are discussed below and are summarized in Table 6-1. None of the variations of these alternatives would have significantly better results than those shown in the table. It should be noted again that operating costs for DMUs are much more uncertain than those for push-pull equipment, but DMU costs significantly lower than those assumed in the calculations are unlikely.

Local Service

For a Local Service extension to Clicquot (extension trains running through to Boston at all times, with no reduction in Needham Heights service) operating Monday through Saturday, new revenue after accounting for diversions from existing services would equal only 14.2% of incremental operating costs. This would be only one third the average on existing MBTA commuter rail lines. With service only on weekdays, the revenue-to-cost ratio for Local Service would increase to 14.8%, but adding Sunday service would reduce it to 13.6%. (With projected ridership growth by the year 2020, the revenue-to-cost ratio for local service would be about 17%.)

Express/Local Service

For an Express/Local Service extension to Clicquot (extension trains running through to Boston at all times, with express service during weekday peak hours) new revenue would equal about 16.8% of incremental operating costs for service Monday through

Saturday. Providing service on weekdays only would increase the ratio to 17.6%. Adding Sunday service would reduce it to 16.1%. (With projected ridership growth by the year 2020, the revenue -to-cost ratio for Express/Local service would be about 20%.)

Combined Trains with Push-Pull Equipment

Combining Needham Heights and Millis trains between Needham Junction and South Station with push-pull equipment would result in a revenue-to cost ratio of 23.5% with service Monday through Saturday or 24.7% with service weekdays only. These ratios would be slightly more than half the commuter rail system average. Because there is currently no Sunday service on the Needham Line, the entire cost of Millis Sunday service would be new. This would bring the revenue-to-cost ratio for seven-day-a week service down to 19.7%. (With projected ridership growth by the year 2020, the revenue -to-cost ratio for push-pull Combined service on weekdays only or weekdays and Saturdays would be about 30%.)

Combined Trains with DMU Equipment

With the relatively short train lengths required to meet the demand on a Millis extension, Combined trains equipped entirely with Diesel Multiple-Unit cars would be slightly more cost-effective than Combined trains with push-pull equipment. Based on the unit costs in the New Bedford/Fall River study, a Millis extension to Cliquot operated in this manner would have a revenue-to-cost ratio of 24.7% for service Monday through Saturday or 25.4% for weekday-only service compared with operating Needham Heights service alone with DMUs. Adding Sunday service would reduce the ratio to 22.5%. (With projected ridership growth by the year 2020, the revenue-to-cost ratio for DMU Combined service on weekdays only or weekdays and Saturdays would be about 30%.)

The operating costs used for DMUs are based on limited data for such equipment, and most of the cars for which data were obtained would have been relatively new. Maintenance costs for railroad cars (as for any transit vehicles) typically increase significantly as the cars age and major components have to be rebuilt or replaced. Therefore, over a longer time span, costs for DMUs are more likely to prove to be higher than those assumed here than to be lower. (Costs used in this study for push-pull trains were based on present MBTA commuter rail rolling stock, mostly ranging from 7 to 10 years old.) It should also be noted that although the Combined service alternatives would have the highest revenue-to-cost ratios of any of the Millis Line service strategies examined, they would have the highest capital costs per new transit rider. This is because most of the capital costs would not vary with ridership, and Combined service would attract much less new ridership than separate through service.

Table 6-1
Cost and Revenue Comparisons
for Millis Extension with Clicquot Terminal

<u>Item</u>	<u>All Local Service</u>	<u>Peak Express/ Off-Peak Local</u>	<u>Combined Millis and Needham Trains Push-Pull</u>	<u>Combined Millis and Needham Trains DMU</u>
Annual Operating Cost Increase	\$7,730,000	\$7,730,000	\$2,855,000	\$2,710,000
Incremental Fare Revenue	\$1,100,000	\$1,300,000	\$670,000	\$670,000
Incremental Revenue/ Operating Cost Increase	0.142	0.168	0.235	0.247
New Transit Riders (1996 travel levels)	850	1,015	470	470

Note: Costs and revenues shown are for service Monday through Saturday, at 1996 travel levels

7. OPERATIONAL ISSUES

Impact of Millis Extension on Other Commuter Rail Services

Impacts of Millis Extension on Needham Branch

Trains running between Boston and Millis would operate over the Needham Branch between Forest Hills and Needham Junction, a distance of 6.9 miles. At present, the Needham Branch is mostly single tracked. There is about one mile of double track at the Forest Hills end. There is one passing siding west of West Roxbury station (at the mid-point between Forest Hills and Needham Junction) and one just east of Needham Junction Station. In scheduling trains on this segment, it is necessary to take into consideration the locations at which inbound and outbound trains will meet. In addition, if trains did not all stop at the same stations, departure intervals would have to be arranged to prevent faster trains from overtaking slower ones traveling in the same direction. Scheduling constraints imposed by the present track layout are discussed in greater detail in appendix D.

At one time, the Needham Branch was entirely double tracked between Forest Hills and Needham Junction, but the second track was removed in the 1940s. Potential scheduling problems could be reduced by reinstalling the second track on the existing grade on at least part of the line. Complete restoration of the second track would require relocation of platforms or parking areas that now occupy portions of the former right-of-way at some stations. The cost of double-tracking has not been included in the capital cost estimates in chapter 5. More detailed engineering studies would be required to determine the amount of double track needed and the amount of relocation of existing facilities involved. (Exclusive of the cost of platform and parking lot relocations, conversion of all single-track segments between Forest Hills and Needham Junction to double track would cost about \$19 million.)

Impacts of Millis Extension on Route North of Forest Hills

Between Forest Hills Station and South Station, Needham Line trains run via the former Boston & Providence Railroad Main Line, now known as the Amtrak New Haven to Boston or NHB Main Line. Millis trains would also do so. This route segment has three tracks, which Needham Line trains currently share with commuter trains originating at various points on the Franklin and Attleboro/Stoughton lines. The segment is also shared with Amtrak intercity passenger trains from New York City and points south.

Schedules of Needham Line trains must be coordinated with those of all of the others on the segment north of Forest Hills. A Millis extension with Millis and Needham Heights trains combined east of Needham Junction would not change the total number of trains using the Needham Line but could require changes in the times at which some Needham Line trains would need to use the NHB Main Line tracks. Under the alternatives with separate Millis and Needham Heights trains, the total number of Needham Line trains using the NHB Main Line during peak periods would double. As

discussed further in appendix D, present overall use of the tracks between Forest Hills and South Station during peak hours is less than their combined theoretical capacity, but the available time slots would not all be optimal for the requirements of a Needham Line with both Needham Heights and Millis service. Furthermore, some of the slots now available will be required for planned expansion of service on other commuter rail routes and the addition of high-speed intercity service.

The feasibility of adding Millis trains to the NHB Main Line would need to be determined by a more detailed analysis than was possible for this study. If capacity of that line was found to be insufficient, it would be possible to route some commuter trains from the Attleboro/Stoughton or Franklin lines via the Dorchester Branch (Fairmount Line) between Readville and South Station. (The Dorchester Branch diverges from the NHB Main Line 5 miles south of Forest Hills, making it inaccessible to Needham Line trains.)

Impacts on Intercity Passenger Service

Historically, the Needham Branch and the Millis Line were never part of a major intercity passenger train route. The Millis Line was once envisioned as part of a route to New York, but as discussed further in appendix H, at its greatest extent it ended near Woonsocket, Rhode Island. Through service between Boston and Woonsocket on this line ended in the 1920s. Because of track abandonments west of Millis, there is no likelihood of future intercity passenger service on this route.

The NHB Main Line, which links the Needham Branch with South Station, is part of Amtrak's Northeast Corridor which runs between Boston, New York, and Washington, D.C. As of October 1997, the Amtrak schedule included nine Boston arrivals and nine departures via this route on weekdays. Three departures but no arrivals were scheduled during the A.M. peak. There was one scheduled arrival during the P.M. peak. Because of the long trip distances, actual arrival times of the intercity trains are much more variable than those of the commuter trains. One train scheduled to arrive in Boston at 6:00 a.m. can actually arrive during the A.M. peak, and one train due at 3:25 P.M. can arrive during the P.M. peak.

Amtrak is now electrifying the segment of the Northeast Corridor between New Haven and Boston. (The segment between New Haven and Washington is already electrified.) Following completion of the electrification in 1999, Amtrak plans to institute high-speed service with hourly Boston arrivals and departures. Some of the existing intercity service will also be retained. The result will be a substantial increase in the number of intercity trains with which operation of Needham Line and other commuter trains on the NHB Main Line will need to be coordinated. In addition to the number of trains, different speed limits will be an issue. Present MBTA policy restricts the maximum speeds of commuter trains to 80 m.p.h., but the speed limit for intercity trains for most of the distance between Back Bay and Forest Hills is 100 m.p.h. This limit may be raised further when the high-speed service is implemented.

Impacts on Freight Service

The NHB Main line between Forest Hills and Back Bay is now used exclusively by passenger trains. This segment of the line is in a cut below street level, with no possibility of future on-line freight use. Conrail freight trains moving between the Beacon Park yard on the Framingham/Worcester Line and the *Boston Herald* printing plant or points in South Boston must cross the NHB Main Line at grade between Back Bay and South Station. Such operation is already restricted to late-night hours because of the heavy volume of passenger trains on this line, so the addition of Millis trains would have little or no impact on the freight service.

At present, the segment of the Needham Branch between Forest Hills and Needham Junction has no freight service. Some warehouses and light industries in West Roxbury were formerly provided with local freight service, but the last such service ended about 15 years ago. If freight service were ever restored on this line in the future, it is unlikely that the volume would be so great as to conflict with passenger service.

The segment of the Millis Line between Medfield Junction and Needham Junction is currently used by the Bay Colony Railroad for access to freight users at points north of Needham Heights. Trains are run on an as-needed basis, usually not exceeding one round trip per day, three days a week. There should be no significant problems in coordinating this service with future passenger service on the Millis Line. There have been no on-line freight users between Medfield Junction and Needham Junction for more than 30 years. With the existing land use along this segment, future demand for on-line freight service is very unlikely.

The segment of the Millis Line south of Medfield Junction is currently used by the Bay Colony Railroad to provide local freight service to industrial plants located near the former Clicquot Station site and at the end of the track near Route 109. (All of the traffic moves to or from the Conrail Framingham Secondary Track at Medfield Junction, so it does not involve the Millis Line north of there directly.) Although the number of freight trains does not usually exceed one each way per day, the process of moving cars in and out of the industrial sidings can block the main track for prolonged periods of time. This service would need to be scheduled so as not to interfere with passenger service on a Millis extension.

A restored Millis Line would cross the Conrail Framingham Secondary Track at grade at Medfield Junction. This line is typically used by three freight trains a day in each direction. Schedules of Millis passenger trains would need to be coordinated with those of the freights to prevent delays to either. The freight trains usually run during mid-day or evening hours, when passenger service headways would be longest and the number of passengers on delayed trains would be smallest.

Impacts at South Station

Millis trains would have South Station as their Boston terminal. The ability of South Station to handle either additional trains or trains at times other than those currently scheduled must be taken into consideration. Millis service provided by adding Millis cars to Needham Line trains that would be running anyway would not change the total number of trips operated, but could change the Boston arrival or departure times of some trains. All weekday Needham Line trains are currently assigned trainsets with 6 or 7 cars. These are short enough to use most tracks in South Station. With Millis cars added, some trains would be up to 9 cars long. These would be unable to use tracks 1 and 2, which are now often used by Needham Line trains.

Millis service provided by separate through trains to Boston would add five trips in each peak period if operated at the present frequency of Needham Heights service. As discussed in appendix D, it appears that South Station could accommodate a greater number of trains than it does at present (including Old Colony Lines service), but a more detailed analysis would be needed to determine how well the available time slots match the needed arrival and departure times of new trains. Some of the present excess capacity will be used by the new high speed intercity service, and by the planned Fall River/New Bedford extensions.

Issues in Operation of Service with Diesel Multiple-Unit (DMU) Trains

In the past, various strategies were used for providing service both to Needham Heights and to points on the Millis Line without over-serving the segment between Needham Junction and Boston. In the final years of service on the Millis Line, there was only one round trip per day, running inbound in the A.M. peak and outbound in the P.M. peak. This was served by a single self-propelled Budd Rail Diesel Car (RDC). In the morning, passengers for Boston usually had to transfer at Needham Junction to a train from Needham Heights. After discharging the passengers at Needham Junction, the Millis car proceeded out of service to Needham Heights to cover the next trip from there. In the evening, the Millis car was usually run through from South Station to Needham Junction attached to the end of a Needham Heights train. At that time, all Needham Heights trains consisted either of RDCs or of locomotive-hauled coaches without push-pull capability. The Millis car was compatible with either of these configurations.

At present, all MBTA commuter rail trains are made up of locomotives and coaches in push-pull configuration. A train in this configuration is operated in one direction from the locomotive (pull mode) and in the other from an engineer's cab in the coach at the opposite end of the train (push mode). A rail diesel car attached to the end of such a train would now have to be capable of serving as the control car for the entire train when running in push mode, in addition to having controls for self-propelled operation when detached. There appears to be no technical reason why this could not be accomplished, although such an arrangement has seldom, if ever, been used in the United States.

A more serious difficulty is that self-propelled diesel railcars are no longer manufactured in North America. Several models of such cars are made in European countries, but their design makes them incompatible with conventional coaches such as those used by the MBTA. Therefore, it would be necessary either to acquire custom-made cars for the Millis extension or to equip all Needham Line trains with diesel railcars. All of the diesel railcars now in production are single-level models, so more cars would be needed to provide a given seating capacity than if double-deck coaches were used. This would require longer maximum train lengths than at present, possibly causing some track-assignment problems at South Station. It would also result in higher capital and maintenance costs than those for double deck trains of equivalent capacity.

At present, none of the trainsets that run on the Needham Line are used exclusively on that route, and none of the three sets that start at Needham Heights on a given day return there at night. Conversion of the Needham Line to DMU operation would require that equipment for this line be kept separate from that used on the rest of the system unless other South Side lines also used DMUs.

One of the arguments in favor of DMU use is the supposed ability to couple and uncouple trainsets with no delays. Some European systems do make use of DMUs that are capable of joining or separating while the trains are in motion. The New Bedford/Fall River commuter rail study concluded that federal regulations would require that standing brake tests be performed after coupling DMUs into trains. It was estimated that this would force the train to be stopped for at least 7 minutes. In situations where the coupling operation would be done at a location other than that where the branches joined, the two trains would have to use the same track for some distance. This would cause additional delay, as signals or operating rules would require that the second train wait for several minutes before following the first over the shared track segment. This would not be an issue for Needham/Millis service, however, as the lines divide at the west end of the Needham Junction platform where coupling and uncoupling would occur.

Issues in Operation of Combined Trains with Push-Pull Equipment

As an alternative to DMUs, it would be possible to operate combined Millis and Needham Heights trains by coupling two trains of push-pull cars, including engines, together at Needham Junction. At present, one outbound Framingham train and one Forge Park train in each direction are operated with two push-pull trains coupled together. This is done to reduce the cost of shifting equipment from one end of the line to the other rather than to increase capacity, but it does demonstrate the technical feasibility of such an operation.

Present practice is for all commuter rail trains to run with the locomotives on the outer end, to minimize noise near the Boston terminal waiting rooms. When double sets are run, this puts the locomotive on the second set in the middle of the train, preventing passengers or train crew from walking between the two sections. On such trains, only

one half is opened for passengers. To maximize efficiency of combined Millis and Needham Heights service, one of the train sets in each pair would have to be run with the locomotive on the inner end. When coupled together, the trains would have the locomotives at the extreme ends and the cab control cars in the middle. Passengers and train crew would then have access to all cars. Although MBTA commuter rail trains do not ordinarily run with locomotives on both ends, they occasionally do so when running in special service outside of their usual territory, again proving the technical feasibility of such operation. The delay incurred in coupling trains and performing brake tests would be about the same for push-pull equipment as for DMUs, or a minimum of about 7 minutes.

8. ENVIRONMENTAL AND COMMUNITY IMPACTS

Impacts on Air Quality

Air quality impacts of transit projects are typically calculated on the basis of expected changes in vehicle miles of travel (VMT) resulting from the project. For the Boston region, the automobile-generated pollutants of greatest concern are carbon monoxide (CO), nitrous oxides (NO_x), and volatile organic compounds (VOC). Based on the present travel modes of the expected users of Millis rail service, an extension to Cllicquot with express service during weekday peak hours and local service at other times would produce the largest reduction in VMT of all the options examined. For this alternative, the net VMT reduction would be about 37,865 per weekday. Of this reduction, 29,235 VMT would result from boardings on the extension itself, and 8,630 from boardings of Millis trains at stations on the present Needham Line.

With local service only, there would be a net reduction of 31,945 VMT per weekday. Of this, 24,330 would result from boardings on the extension itself, and 7,615 from boardings of Millis trains at stations on the present Needham Line. Service with Millis trains combined with Needham Heights trains between Needham Junction and Boston would result in the smallest VMT reduction of any of the alternatives examined. For this alternative, the net VMT reduction would be about 23,625 per weekday. This would include reductions of 21,935 from boardings on the extension itself, and 1,690 from new boardings at Needham Line stations. (The latter would be attracted by parking capacity being freed up by diversions to the extension rather than by service changes.)

The improvements in air quality associated with VMT reductions for these Millis extension alternatives would be as shown in Table 8-1. At the same time, however, the diesel locomotives or railcars used on trains would add emissions to the air. In addition to CO, NO_x, and VOC, particulate matter (PM) is of concern for diesel vehicles. For the same three alternatives, locomotive emission increases would be as shown in Table 8-2. The net impact of the reduction in auto emissions and increase in locomotive emissions would be as shown in Table 8-3. Emissions characteristics of DMUs would depend on the particular model of car used. The figures in Tables 8-2 and 8-3 are based on cars with fuel consumption characteristics similar to those of Budd RDCs with new engines.

All of the alternatives analyzed would result in overall reductions in CO levels and VOC levels but increases in NO_x and particulate matter levels. The greatest reductions in VMT and in CO and VOC levels would be produced by serving Millis with express trains to Boston in peak hours and through local trains in off-peak hours. This alternative would, however, also have the second-largest increase in NO_x of all the alternatives shown, and would be tied with all-local service for the largest increase in PM.

Table 8-1
 Millis Extension
 Reduction in Average Weekday Auto Emissions

	<u>All Local</u>	<u>Express/Local</u>	<u>Combined Trains</u>
VTM Reduction	31,945	37,865	23,625
CO Reduction	320.5 kg	379.9 kg	237.0 kg
NOx Reduction	54.1 kg	64.2 kg	40.0 kg
VOC Reduction	29.9 kg	35.4 kg	22.1 kg

Table 8-2
 Millis Extension
 Increase in Average Weekday Train Emissions

	<u>All Local</u>	<u>Express/Local</u>	<u>Combined Trains Push-Pull</u>	<u>Combined Trains DMU</u>
CO Increase	33.3 kg	33.3 kg	44.6 kg	4.9 kg
NOx Increase	353.0 kg	353.0 kg	325.7 kg	72.1 kg
VOC Increase	11.8 kg	11.8 kg	13.3 kg	1.6 kg
PM Increase	4.6 kg	4.6 kg	2.9 kg	1.1 kg

Table 8-3
 Millis Extension
 Net Change in Average Weekday Emissions

	<u>All Local</u>	<u>Express/Local</u>	<u>Combined Trains Push-Pull</u>	<u>Combined Trains DMU</u>
CO Change	-287.2 kg	-346.6 kg	-192.4 kg	-232.1 kg
NOx Change	+298.8 kg	+288.8 kg	+285.6 kg	+32.1 kg
VOC Change	-18.1 kg	-23.7 kg	-8.8 kg	-20.5 kg
PM Change	+4.6 kg	+4.6 kg	+2.9 kg	+1.1 kg

Impacts on Water Resources

A Millis extension terminating at Clicquot would operate entirely over a line that is now used for local freight service, with the exception of a short segment at Medfield Junction. Passenger service would, however result in a large increase in the number of trains using the line. The active portion of the Millis Line makes two crossings of the Charles River on long open-deck wooden trestles. The inactive segment at Medfield Junction crossed a brook on a short open-deck girder bridge. The cost estimates in chapter 5 assume that all of these bridges would be replaced with new bridges that would be provided with drainage systems to prevent pollutants such as brake dust and oil from being dropped in the water by trains.

Small stone culverts carry brooks under the right-of-way in several locations. Some of these may require some upgrading to carry passenger trains. Drainage improvements would be made as necessary at these and other locations where the rail line is in close proximity to wetlands.

Impacts on Community and Cultural Resources

This impact category covers changes that would occur to historic buildings, sites, or districts, to archeological sites, to parks or open spaces, and to buildings or resources that are important to the expression of cultural values, such as schools, churches, and monuments.

Most of the land adjoining the route between Needham Junction and Millis is either sparsely developed or is used for industrial purposes. There do not appear to be any structures or sites on the portions of the line within Needham or Medfield that would be classified as cultural or community resources. In Dover, the extension would pass directly through the town center. Near the assumed station site there are two churches, one about 200 feet and the other about 300 feet from the west side of the track. The town Hall is about 300 feet from the east side of the track. An elementary school is about 400 feet east of the track, but is separated from it by several stores. The former railroad station building at Dover has been extensively altered from its original design, reducing its historic value. It currently houses several antique shops which could be relocated elsewhere if disturbed by passenger train service.

An extension terminating at the Clicquot site in Millis would not impact cultural or community resources in that town.

Traffic Impacts on Major Arterial Routes

The reductions in auto travel resulting from a Millis extension would be distributed over several different routes. There is no readily available information as to the current division of traffic among these routes. Based on relative travel times, it is likely that the Mass. Turnpike east of Route 128 carries the largest share of Millis corridor traffic of any individual route alternative. If all auto trip diversions to the extension came from the Turnpike, the Express/Local service alternative would remove about 460 cars each way per day at present travel levels. The highest concentration of these would occur between 8:00 and 8:30 A.M., when about 110 eastbound cars would be removed. This would be less than 3% of the capacity of this road over the same time span.

The greatest traffic reduction on an undivided state highway would occur on Route 109 between Medfield and Route 128. The maximum reduction there would be about 325 vehicles per day, with about 75 of these in the peak half hour. This route is currently congested in peak hours, especially in the segment nearest Route 128. Mass. Highway Department counts indicate that daily traffic on Route 109 at Medfield Center nearly doubled from 10,970 in 1988 to 20,000 in 1994. Boston and Cambridge commuters account for only a small portion of this volume, so a commuter rail extension would

reduce traffic on this segment during the heaviest 30 minutes of travel by about 15% at most.

Traffic Impacts of Station Access

Boardings on a Millis extension would be divided among three stations. The Medfield station would be the most heavily used of these. Under the Express/Local service alternative, this station would serve an estimated 595 riders per day at 1996 travel levels. The Millis terminal would be second, with 465 boardings. The Dover station would have the fewest boardings, at 300.

Including vehicles arriving either to park or to drop off passengers, the most heavily used train would generate about 100 auto-access trips to the Medfield Station, about 95 to the Millis station, and about 50 to the Dover Station. In the final minutes prior to this train departure, auto arrivals would average about 11 per minute at Medfield, 10 per minute at Millis, and 5 per minute at Dover. These arrival rates would be lower than the peak rates at either Walpole or Norfolk, the two stations now most frequently used by residents of the Millis extension service area. These access trips would not all be from one direction at any of the three stations, but some modifications to Route 109 would be needed to prevent vehicles approaching a Millis station from the west from causing traffic backups at the turnoff point.

Grade Crossings

The rail line between Needham Junction and Clicquot has 10 grade crossings of public roads. Traffic counts have not been made at these crossings, but none of them appear to be heavily traveled ways. At certain times of day, trains crossing Union Street in Millis (just east of Clicquot) could cause some delays for workers going to or from the GAF roofing plant located on that street.

Impacts on Abutters

Negative impacts for residents of houses abutting a Millis extension would consist of noise and vibration from trains as they pass and the sounding of train horns at the grade crossings. These impacts would be greatest on houses located within 200 feet of the right-of-way.

Most of the land in the immediate vicinity of the rail line from Needham Junction to Millis is sparsely developed, but there are clusters of houses at several points along the line. Between Needham Junction and Clicquot there are about 110 houses within 200 feet of the railroad alignment. Of these, 25 are in Needham, 45 in Dover, 30 in Medfield, and 10 in Millis. Because much of the vacant land in the towns in the Millis Line corridor adjoins the right-of-way, the number of houses within 200 feet of the route may increase substantially from the total above in future years.

9. SUMMARY AND CONCLUSIONS

A commuter rail extension to Millis from Needham Junction would be feasible from an operations standpoint but would produce limited benefits for the costs involved. At 1996 travel levels, stations on a Millis extension would serve about 1,210 inbound boardings on a typical weekday if all service were provided by trains that also stopped at all stations on the Needham Line from Needham Junction through Forest Hills. Of these riders, about 425 (35%) would be new transit users. The remainder would be diverted from other transit services. If Millis trains made no stops on the Needham Line except Needham Junction and Hersey, extension boardings would increase to 1,360 per day, of which 545 (40%) would be former auto drivers or passengers. Combining Millis trains with Needham Heights trains between Needham Junction and Boston would reduce extension boardings to 1,150 per day, including 365 new transit users. The number of new transit users would increase to about 535 with local service, 685 with express service, or 455 with combined trains by the year 2020. A further extension beyond Millis to Medway would be much less feasible because of the present condition of the former rail right-of-way, and would attract no more new transit riders than an extension terminating in Millis.

All of the Millis service options would attract some new transit users to present Needham Line stations as a result of added frequency or faster running times. Some Needham and Framingham/Worcester Line stations would also gain riders as the result of freed-up parking capacity. At 1996 travel levels, these gains would total about 425 with all-local service from Millis, 470 with peak-period express service, or 105 with combined trains. Because of stable populations in the areas from which these riders would be attracted, each of these totals would increase by less than 10% by the year 2020.

The maximum highway traffic reduction resulting from a Millis extension would occur on the Mass. Turnpike east of Route 128. The reduction there in the number of peak-direction vehicles during commuting hours would be less than 3% of the total capacity of the road. Traffic on Route 109 during the heaviest 30 minutes of travel would be reduced by about 15% at most as the result of the extension.

Local trains on a Millis extension would have travel times ranging from one minute slower to nine minutes faster than typical driving times to the South Station area of Boston from the vicinities of the extension stations. Express trains would provide line-haul travel times ranging between 10 and 20 minutes faster than driving times. Express train times from Millis Line stations to Boston would also be significantly faster than current scheduled express bus times from this corridor, but few residents of the extension service area now use the buses.

Of the Millis extension alternatives analyzed, service with Millis and Needham Heights trains combined between Needham Junction and Boston would have the highest ratio of incremental revenue to incremental operating cost. Including riders at extension station and new riders attracted to existing Needham Line stations, revenue for such an

alternative at 1996 travel levels would cover about 24% of incremental operating cost if provided with conventional push-pull equipment. Substitution of Diesel Multiple-Unit (DMU) trains would raise the ratio to about 25%. For comparison, in 1996, the revenue-to-cost ratio for the MBTA commuter rail system as a whole was about 42%. A Millis extension with separate trains and peak-period express service would have a revenue-to-cost ratio of about 17%. With local service only, the ratio would be 14%.

Capital costs for necessary right-of-way improvements, station platforms and parking, and additional rolling stock would total \$111.5 million for an extension from Needham Junction to Clicquot with local service only. These costs would increase only slightly with peak-period express service, to \$112.0 million. With Millis and Needham Heights trains combined east of Needham Junction using push-pull equipment, capital costs for the extension would total \$93.1 million. Substitution of DMUs would raise these costs to \$109.0 million after allowances for redeployment of present rolling stock to other routes.

Capital costs per new inbound transit rider at estimated year 2020 ridership levels for the various Millis extension alternatives are shown in Table 9-1. The most cost-effective alternative in this measure (extension to Clicquot with peak-period express service) would have a capital cost per new transit rider slightly lower than that of the Newburyport extension, currently estimated at \$93,055. (The estimated cost per new year 2020 transit rider for the Worcester extension is \$45,732.)

The Millis results shown are dependent on the estimates of new transit ridership produced by the manual method discussed in chapter 4 and appendix G. Forecasts from the CTPS Regional Model show much lower total ridership, with higher proportions of the riders being diverted from existing transit services. This would result in much higher average capital costs per new transit rider than shown in the table.

Any of the Millis extension alternatives analyzed would improve air quality slightly. At present travel levels, the capital cost per weekday kg of VOC elimination would range from \$4.7 million for a Clicquot extension with peak-period express service to \$10.4 million with combined Millis and Needham Heights trains using push-pull equipment. These figures cannot be compared directly with those for commuter rail extensions analyzed in the PMT, because the latter were calculated by an older method that did not include increases in emissions from locomotives.

The findings in this chapter are summarized in Table 9-1.

Table 9-1
Summary of Performance Measures for
Millis Extension from Needham Junction to Clickquot

<u>Item</u>	<u>All Local Service</u>	<u>Peak Express/ Off-Peak Local</u>	<u>Combined Millis and Needham Trains Push-Pull</u>	<u>Combined Millis and Needham Trains DMU</u>
Weekday Inbound riders at extension stations (1996 travel levels)	1,210	1,360	1,150	1,150
New Inbound Transit Riders (New stations - 1996 travel levels)	425	545	365	365
New Inbound Transit Riders (New and existing stations - 1996 travel levels)	850	1,015	470	470
New Transit Riders (year 2020)	990	1,185	565	565
Annual Operating Cost	\$7,730,000	\$7,730,000	\$2,855,000	\$2,710,000
Incremental Fare Revenue (1996 travel levels)	\$1,100,000	\$1,300,000	\$670,000	\$670,000
Incremental Revenue/ Operating Cost	0.142	0.168	.235	0.247
Capital Cost	\$111,495,000	\$112,010,000	\$93,095,000	\$108,995,000
Capital Cost/New Rider (year 2020)	\$112,621	\$94,523	\$164,770	\$192,912
Weekday VOC Reduction (1996 travel levels)	18.1 kg	23.7 kg	8.8 kg	20.5 kg
Capital Cost/Kg of Weekday VOC Reduction	\$6,159,945	\$4,726,160	\$10,578,977	\$5,316,829

APPENDIX A - FURTHER DETAILS ON EXISTING PUBLIC TRANSPORTATION SERVICE IN STUDY AREA

Chapter 2 of this report provides a general description of the existing bus route serving the Millis extension corridor. The first section of this appendix describes the bus route in greater detail. The second section contains transit ridership information for the Millis Line corridor.

Description of Brush Hill Milford-Boston Route

At present, all four towns in the service area of a Millis extension are served directly by an express bus route from Milford to Boston. This route, operated by the Brush Hill Transportation Company with assistance from the MBTA/EOTC Interdistrict Transportation Service (IDTS) program, is the only fixed-route public transportation service within these towns. The outer terminal of this route is at Main and School streets in downtown Milford. (For reasons discussed in chapter 2 this report, Milford was assumed to be outside of the service area of a Millis extension.) Proceeding on state Route 16 to the start of Route 109 in Milford, buses then run entirely on Route 109 through Medway, Millis, Medfield, and Dover to Westwood. In Westwood the buses also follow Route 109, except for a diversion of about one mile on Pond Street. From the Westwood/Dedham town line, the buses use Route 128 and the Mass. Turnpike to Copley Square in Boston, continuing via local streets to their final stop near South Station.

Published schedules for the route list four stops in Milford, eight each in Medway and Millis, five in Medfield, one in Dover, and 11 in Westwood. (The segment in Dover is only about one half mile long, on the Dover/Walpole town line. The route enters Walpole for a short distance, but makes no stops there.) Stops at the inner end of the route are at Copley Square, Park Square, and at Kneeland and Lincoln Streets, near South Station. Detailed passenger origin-destination information for this route is not readily available. An observation by CTPS of one outbound trip on an average day in May 1997 found a total of six passengers. Of these, three alighted in Westwood, two in Medway, and one in Milford. There were no alightings in Dover, Medfield, or Millis, and no boardings after the bus left Boston.

Census and Survey Transit-Ridership Totals from Millis Corridor

U.S. Census Journey-to-Work tabulations include breakdowns of work trips to Boston Proper, other Boston, and Cambridge from each city and town of residence, by mode of travel. Within modes, these figures do not indicate which route is used if there is more than one possibility, and commuters who alternate among two or more modes are counted under only one of them. Nevertheless, these data provide a general picture of the extent to which residents of individual towns use mass transit to travel to work. Information on origins, destinations and trip purposes of passengers using MBTA commuter rail, express bus, and rapid transit lines is available from surveys conducted between 1993 and 1995. This provides a cross-check on the Census data. Results for

towns in the service area of a Millis extension from Needham Junction are summarized below. (Total commuter rail trips for all purposes from the same towns based on 1993 survey results appear in Table 2-1 in this report.)

Millis

Of the three towns that would be served directly by a Millis extension, Millis has the second-largest population, and also ranks second in the number of Boston and Cambridge work trips generated. Official U.S. Census estimates for 1996 (the most recent year for which estimates have been completed) show a population of 7,965 in Millis.

According to the 1990 Census figures, Millis originated 610 work trips to all of Boston or Cambridge, of which 93 (15%) were made by mass transit. Of these, commuter rail captured the largest share, with 69 (11%), followed by express bus with 18 (3%), and trolley or subway with 6 (1%). Comparisons with more recent MBTA survey data indicate that the overall transit share is understated in the Census figures, however. Expanded responses from the 1993 commuter rail survey show 97 work trips from Millis to Boston or Cambridge by that sub-mode alone. Other surveys show about 10 Boston or Cambridge work trips on MBTA buses or rapid transit lines.

Some of the discrepancy between Census and survey data may be a result of passengers shifting to commuter rail from the Milford bus route, which now carries almost no Millis residents. In the survey, the most common commuter rail boarding station by far for Millis residents was Norfolk, with smaller numbers scattered among other stations on the Franklin, Needham, and Framingham/Worcester lines. Millis residents using MBTA subway or trolley service boarded mostly at Forest Hills station on the Orange Line or at Woodland Station on the Green Line.

Medfield

Medfield has the largest population of the three towns on a Millis extension and also ranks first in the number of Boston and Cambridge work trips generated. The Census estimates for 1996 show a population of 11,467 in Medfield.

According to the 1990 Census figures, Medfield originated 1,047 work trips to all of Boston or Cambridge, of which 279 (27%) were made by mass transit. Of these, commuter rail captured the largest share, with 252 (24%), followed by trolley or subway with 18 (2%), and express bus with 6 (1%).

The 1993 commuter rail survey showed 323 work trips from Medfield to Boston or Cambridge by that sub-mode alone. In the survey, the most common commuter rail boarding station by far for Medfield residents was Walpole, with smaller numbers scattered among other stations on the Franklin, Needham, Attleboro/Stoughton and Framingham/Worcester lines.

Other surveys show about 25 Boston or Cambridge work trips from Medfield on trolley or subway lines, with 9 boardings on the Green Line, 10 on the South Shore branch of the Red Line, and 6 on the Orange Line. Most Medfield residents who formerly used the Milford express bus have apparently now shifted to commuter rail. Survey results indicate that three Medfield residents board MBTA express buses at Riverside.

Dover

Dover has the smallest population of the three towns directly on a Millis extension but is only slightly below Millis in the number of Boston and Cambridge work trips generated. The Census estimates for 1996 show a population of 5,383 in Dover.

According to the 1990 Census figures, Dover originated 599 work trips to all of Boston or Cambridge, of which 194 (33%) were made by mass transit. Of these, commuter rail captured the largest share, with 149 (25%), followed by trolley or subway with 35 (6%), and express bus with 10 (2%).

Comparisons with survey data indicate that the Census results overstate use of mass transit by Dover residents. The 1993 commuter rail survey showed only 100 work trips from Dover to Boston or Cambridge by that sub-mode, with the greatest concentrations of boardings being at Needham Junction on the Needham Line and Wellesley Square on the Framingham/Worcester Line. Other surveys show 12 Boston or Cambridge work trips from Dover on trolley or subway lines, all on the Green Line. Another six Dover residents boarded MBTA express buses at Riverside. There appears to be little or no use of the Milford express bus by Dover residents at present.

Medway

For reasons discussed in appendix F, a Millis extension would probably not serve Medway directly, although Medway is considered to be in the service area of the extension. In total population, Medway was slightly below Medfield as of the most recent estimates, but Medway is growing at a faster rate. The Census estimates for 1996 show a population of 11,391 in Medway, versus 11,467 in Medfield.

According to the 1990 Census figures, Medway originated 400 work trips to all of Boston or Cambridge, of which 124 (31%) were made by mass transit. Of these, commuter rail captured the largest share, with 112 (28%), with the remaining 12 being made by express bus. The 1993 commuter rail survey showed 122 work trips from Medway to Boston or Cambridge by that sub-mode. The most common commuter rail boarding station for Medway residents was Norfolk, with smaller numbers scattered among other stations on the Franklin and Framingham/Worcester lines. Other surveys show three Boston or Cambridge work trips from Medway on trolley or subway lines, all on the Green Line, but none on MBTA express buses. An estimated 5 to 10 Medway residents use the Milford express bus now.

Sherborn

Sherborn would not be served directly by a Millis commuter rail extension, but it adjoins Medfield which would have a station. The Local Service and Combined Trains alternatives for the Millis Line would not improve travel times for most Sherborn residents compared with present mass transit alternatives, but the Express Service alternative would. Therefore, Sherborn is included in the extension service area.

Sherborn has the lowest population and the lowest population growth rate of any of the towns in the extension service area. The Census estimates for 1996 show a population of 4,107 in Sherborn.

According to the 1990 Census figures, Sherborn originated 433 work trips to all of Boston or Cambridge, of which 101 (23%) were made by mass transit. Of these, commuter rail captured the largest share, with 79 (18%), followed by express bus with 13 (3%) and trolley or subway with 9 (2%)

The results of the 1993 survey were consistent with the Census commuter rail figure, showing a total of 85 work trips to Boston or Cambridge from Sherborn. Boardings were dispersed among several stations on the Framingham/Worcester and Needham Lines, with the largest number occurring at Wellesley Square (29) followed by West Natick (18) and Natick (16). No other station accounted for more than 10 boardings from Sherborn. Other surveys show 8 Boston or Cambridge work trips from Sherborn on trolley or subway lines, all on the Green Line. This is also consistent with the Census results. Only two Sherborn origins were found among MBTA express bus passengers, but Sherborn residents also have access to private-carrier express bus service to Boston from Shopper's World in Framingham.

APPENDIX B - DETAILS OF TRAVEL TIME COMPARISONS BETWEEN MILLIS EXTENSION AND EXISTING OPTIONS

Travel times to Boston from stations on a Millis extension from Needham Junction are discussed in chapter 3 of this report. Table 3-1 compares these times with estimated driving times to Boston. This appendix contains additional travel time comparisons between a Millis extension and present bus and rail alternatives.

Millis

On the existing Milford-Boston bus route, the stop nearest to a commuter rail station at Clicquot would be that at Route 109 and Milliston Road. At that point, the rail line is about one-quarter mile north of Route 109. The scheduled bus running time from Milliston Road to Boston is about 60 minutes to Lincoln Street or 48 minutes to Copley Square. (On the one trip timed by CTPS, traffic delays added 7 minutes between Copley Square and Millis.) For comparison, the projected running time for a local train from Clicquot to Boston is 49 minutes to South Station or 44 minutes to Back Bay Station, near Copley Square. An express train would reduce these times by 11 minutes.

Disregarding slight differences in access and egress distances, a local train would save 11 minutes to the South Station area or 4 minutes to the Copley Square area compared with scheduled bus times from Millis. For an express train, the savings would be 22 and 15 minutes. With typical traffic delays for the bus, the actual savings for either train alternative would be even greater. Few Millis residents currently use the buses, however.

The most commonly used transit alternative for Millis residents traveling to Boston or Cambridge is the Franklin commuter rail line from Norfolk Station. Scheduled running times to Boston from Franklin vary among trains, depending on the number of intermediate stops served. At present, the average scheduled time for all inbound A.M. peak and outbound P.M. peak trains combined is 49 minutes between Norfolk and South Station. This is the same as the estimated running time for a local train from Clicquot to South Station. Millis Line trains would serve the same downtown Boston stations as Franklin Line trains, so the only difference in overall travel time would be that resulting from shorter access time to Clicquot.

From most points in Millis, the shortest access route to Norfolk Station would involve using state Route 115, which runs close to both Norfolk Station and the assumed Clicquot station site. The distance from the Millis/Norfolk town line to Norfolk Station via Route 115 is 2.0 miles. The distance to Clicquot from the same point is 2.4 miles. Therefore, access distance to Clicquot would be shorter than that to Norfolk Station from any home in Millis located more than 0.2 miles from the Norfolk town line. At present, almost all houses in Millis meet this criterion.

With express service on both routes, line-haul time from Clicquot station would decrease by 11 minutes, but that from Norfolk Station would decrease by 14 minutes.

Within Millis, this would move the equal travel-time trade-off point between the two routes to about 0.7 miles from the Norfolk town line, but travel times to Boston from most Millis homes would still be faster via Clicquot. Express service from Norfolk would offer faster overall travel time to Boston than local service from Clicquot for all of Millis.

Medfield

In Medfield, the nearest bus stop to a Medfield Junction station site is on Route 109 near Route 27. At that point, the rail line is about 1.2 miles north of Route 109. The scheduled bus running time from Route 27 to Boston is about 54 minutes to Lincoln Street or 42 minutes to Copley Square. (On the one trip timed by CTPS, traffic delays added 9 minutes between Copley Square and Medfield.) The projected running time from Medfield Junction to South Station is 45 minutes for a local train or 34 minutes for an express, with times to Back Bay being 5 minutes less.

Comparing only line-haul times, a local train would save 9 minutes to the South Station area or 2 minutes to the Copley Square area compared with scheduled bus time from Medfield. For an express train, the savings would be 20 and 13 minutes. With typical traffic delays for the bus, the actual savings for either train alternative would be even greater. The bus would offer the advantage of more choices of stops, including several located more centrally than the rail station. Few Medfield residents currently use the buses, however.

The most commonly used transit alternative for Medfield residents traveling to Boston or Cambridge is the Franklin commuter rail line from Walpole Station. At present, the average scheduled time for all inbound A.M. peak and outbound P.M. peak trains combined is 43.5 minutes between Walpole and South Station. This is 1.5 minutes less than the estimated running time for a local train from Medfield Junction to South Station. Millis Line trains would serve the same downtown Boston stations as Franklin Line trains, so the only difference in overall travel time would be that resulting from shorter access time to Medfield Junction.

From most points in Medfield, the shortest access route to Walpole Station would involve using state Route 27, which runs close to both Walpole Station and the assumed Medfield Junction station site. The distance from the Medfield/Walpole town line to Walpole Station via Route 27 is 1.2 miles. The distance to Medfield Junction from the same point is 3.9 miles. Overall travel time to Boston would be faster via Walpole than via Medfield Junction from origins more than one mile south of Route 109, but the majority of Medfield homes are north of this trade-off point.

With express service on both routes, line-haul time from Medfield Junction would decrease by 11 minutes, but that from Walpole Station would decrease by 15 minutes. Within Medfield, this would move the equal travel-time trade-off point between the two routes to about 0.3 miles south of Route 109. Express service from Walpole would

offer faster overall travel time to Boston than local service from Medfield Junction for all of Medfield.

Dover

The one bus stop in Dover is about three miles from the town center, assumed to be the site of a Dover railroad station. The scheduled bus running time from the Dover stop to Boston is about 49 minutes to Lincoln Street or 37 minutes to Copley Square. (On the one trip timed by CTPS, traffic delays added 8 minutes between Copley Square and Dover.) The projected running time from Dover Station to South Station is 39 minutes for a local train or 28 minutes for an express, with times to Back Bay being 5 minutes less.

Comparing only line-haul times, a local train would save 10 minutes to the South Station area or 3 minutes to the Copley Square area compared with scheduled bus time from Dover. For an express train, the savings would be 21 and 14 minutes. With typical traffic delays for the bus, the actual savings for either train alternative would be even greater. For riders destined for the South Station area, the longer line-haul bus time would not be offset by faster access time to the bus stop from any origin in Dover. Overall bus travel times to Copley would be faster than train times from a small number of Dover homes. Few Dover residents currently use the buses, however.

The most commonly used transit alternatives for Dover residents traveling to Boston or Cambridge are the Needham commuter rail line from Needham Junction Station or the Framingham/Worcester Line from Wellesley Square Station. At present, the average peak scheduled train time to South Station is 33.5 minutes from Needham Junction or 34.5 minutes from Wellesley Square. The estimated time from a Dover station is 39 minutes for a local train or 28 minutes for an express train. All peak-period trains serving either Wellesley Square or Needham Junction are now run as locals. Express trains from a Millis extension would stop at Needham Junction, providing a running time of about 23 minutes from there to South Station. If the Millis Line had only local service, it is unlikely that Needham Junction would have express service. For purposes of comparison, it is assumed that Wellesley Square would continue to have only local service in peak hours.

No numbered state highways pass through Dover, so all travel within Dover or between Dover and neighboring towns uses local roads. From most points in Dover, the shortest route to Needham Junction Station is via Dedham Street in Dover and Chestnut Street in Needham. From the Dover/Needham town line, the distance to Needham Junction Station via this route is 0.9 miles. The distance to the assumed Dover station site is 2.8 miles. With either express or local service, the running time to South Station would be about 5 minutes less from Needham Junction than from Dover. Overall travel times to Boston would be faster via Needham Junction than via Dover Station from origins less than 1.8 miles from the Dover/Needham town line. On Dedham Street this would be about at Cross Street. The majority of houses in Dover are

within the area for which Dover Station would provide faster travel times, but travel times would continue to be faster via Needham Junction for many Dover residents.

From most points in Dover, the shortest route to Wellesley Square Station is via Main Street and Dover Road in Dover, Charles River and Grove streets in Needham, and Grove Street in Wellesley. The distance from the Dover/Needham town Line to Wellesley Square via this route is 2.4 miles. The distance to the assumed Dover station site is 1.9 miles. The average train time from Wellesley Square to Boston would be 4.5 minutes less than that of a local train from Dover. Overall travel times to Boston would be faster via Wellesley Square than via Dover from origins less than 0.5 miles from the Dover/Needham town line. On Main Street this would be about at Claybrook Road. Most houses in Dover are within the area for which local service from Dover Station would provide faster travel times than local service from Wellesley Square. Express service from Dover would provide faster travel times for all Dover residents than local service from Wellesley Square.

Sherborn

At present, Sherborn has no direct mass transit service. Most Sherborn residents traveling to Boston or Cambridge from Sherborn use the Framingham/Worcester commuter rail line. Boardings are dispersed among several stations, with the largest individual share going to Wellesley Square. The average peak scheduled train time to South Station from there is currently 34.5 minutes. The station nearest to Sherborn on a Millis extension would be the one in Medfield, assumed for purposes of analysis to be at or near the former Medfield Junction Station site. The estimated running time from there to South Station would be 45 minutes for a train making all intermediate stops or 34 minutes for a train running non-stop between Hersey Station and Ruggles Station.

The driving time to Wellesley Square from the center of Sherborn is about 15 minutes. The driving time from the center of Sherborn to Medfield Junction would be about 11 minutes. Therefore, the combined access and on-train time using a local train from Medfield Junction would be 6.5 minutes longer than the time via Wellesley. The difference would be smaller from points closer to the Medfield town line, but residential distribution is such that only a small number of homes are located where travel times via Medfield Junction would be faster than those via Wellesley. For this reason, it was concluded that the only Sherborn residents who would be attracted to local service on the Millis Line would be a small number who now use stations on the Needham Line.

With express train service from Medfield Junction, combined access and on-train time to Boston from the center of Sherborn would be 4.5 minutes faster than that via Wellesley Square. The difference would be smaller from points between the center of Sherborn and the Wellesley town line, but almost all Sherborn homes are located within areas from which service via Medfield Junction would be faster.

When the 1993 survey was conducted, service on the Framingham/Worcester Line ran only as far west as Framingham, and all peak-direction trains stopped at all stations.

There is now some express train service from Framingham, West Natick, and Natick provided by trains from Worcester. Framingham and West Natick are expected to have more express service after the full implementation of the Worcester extension. At present, the scheduled running time for an express train from West Natick to South Station with no stop at Natick is 30 minutes. The average access time from the center of Sherborn to West Natick is about 10 minutes. Therefore, overall access and on-train time to Boston would be five minutes faster using express train service from West Natick than using express train service from Medfield Junction. The difference would be less from points closer to the Medfield town line, but relatively few homes would be located within areas from which service via Medfield Junction would be faster than service via West Natick. Therefore, even with express service on the Millis Line Sherborn would not contribute substantial ridership.

Medway

Medway is not currently served directly by any commuter rail line. The private-carrier express bus route from Milford to Boston described in appendix A has several stops in Medway, but ridership is very low. Most Medway residents who travel to Boston or Cambridge by public transportation use Franklin Line commuter rail service. The results of the 1993 survey show that the largest share of Medway commuter rail riders (88, or 61%) boarded at Norfolk Station. At present, the average scheduled time for all inbound A.M. peak and outbound P.M. peak trains combined is 49 minutes between Norfolk and South Station.

On a Millis extension terminating in Millis, the Millis station would be the nearest one on the line to all points in Medway. The estimated running time to South Station from a Clicquot station for a train making local stops on the Needham Line would be 49 minutes, or the same as the present average time from Norfolk Station. For an express train from Clicquot, the time to South Station would be 38 minutes. If express service were implemented on the outer end of the Franklin Line, the running time to South Station would be about 39 minutes. Therefore, on-train times from either Clicquot or Norfolk would be about the same if local service is compared with local service or express with express.

The most direct driving routes to Norfolk Station from points in Medway all pass through portions of Millis. The travel times and distances to Clicquot would be less than those to Norfolk Station from the points where each of the access routes from Medway to the two stations divide. Therefore, most Medway residents would be likely to choose commuter rail service at Millis over present transit alternatives. If express service were implemented on the outer end of the Franklin Line, local train service from Millis would be less competitive than Millis express service for travel from Medway. Nevertheless, from points in Medway north of Route 109, even local Millis trains would provide the fastest rail option.

APPENDIX C - CALCULATION OF ROLLING STOCK REQUIREMENTS FOR MILLIS EXTENSION

Rolling stock requirements for each Millis extension alternative were first calculated in terms of the number of locomotives and coaches that would be required to operate the schedule including the extension but would not be required without it. For the alternatives using push-pull equipment, each new train set would have one locomotive. Coach requirements were based on provision of seats for all new peak-period riders, using double-deck coaches with 185 seats each. (These estimates may be low, as demand would not necessarily divide among trains in even multiples of 185.) Table C-1 summarizes the ridership components that were considered in computing coach requirements for each alternative. As discussed in chapter 6, minimum train-length requirements dictated by the present operating policy on South Side lines would require more coaches for most alternatives than would be required by capacity considerations alone.

The assumed schedules for either Local or Express/Local service on a Millis extension would include five inbound A.M. peak trains and five outbound P.M. peak trains. In either case, only one train set would have time to complete a round trip from Millis to Boston fast enough to cover two departures in each peak period, so four train sets would be needed for the four trips.

With a typical split of peak and off-peak ridership, 1,030 of the 1,210 predicted inbound weekday boardings at Millis extension stations under the Local Service alternative would board in the A.M. peak. This would include about 145 riders who would otherwise use stations on the present Needham Line, about 560 riders diverted from other transit services, and about 325 new transit riders. In addition, about 470 A.M. peak riders would shift to existing Needham Line stations from autos or from other transit facilities. Capacity for the 145 riders diverted to the extension from present Needham Line stations would be provided by redeploying cars from the existing fleet. Eight double-deck coaches would be needed to provide seats for all 1,355 of the riders added at Millis extension and Needham Line stations combined. This is equivalent to the capacity of 7.3 double-deck coaches. The proportion of the ridership carried on the first trip (run by the same train set as the fifth trip) would be sufficient to bring the added capacity requirement for the other four trips down to seven coaches. One of these could be shifted from the Franklin Line because of capacity freed up by diversions to the Millis extension, resulting in a net requirement of six.

In the Express/Local alternative, peak-period boardings on the extension would be greater than with Local service, but ridership increases at existing Needham Line stations would be smaller. Added ridership for the extension and Needham Line combined would total 1,380, or the capacity of 7.5 double-deck coaches. As under the Local service alternative, the added coach requirement would be six.

With Millis and Needham Heights trains combined between Needham Junction and South Station, added running time would reduce A.M. peak boardings at extension

stations to 980. Only 75 additional riders would be attracted to existing stations (all as the result of freed-up parking capacity) versus 145 diverted to the extension. The net impact would be 910 added riders on the extension and Needham Line combined, requiring five additional coaches. The first trip with the repeating train set would not carry a large enough share of the riders to reduce this total.

With Needham Heights and Millis trains combined east of Needham Junction using DMUs, it would be necessary to replace all equipment used on the present Needham Line with such cars in addition to acquiring equipment for the extension itself. Based on present equipment designs, the seating capacity of a DMU would be about 120 at most. This would require 20 cars just to provide capacity for present peak-period Needham Line riders. The net additional ridership as the result of the Millis extension would require another eight cars, making a total of 28. If DMUs with seating capacity of less than 120 were used, the total equipment requirement would increase.

Table C-1
Sources of A.M. Peak Ridership on Millis Extension
and New Coach Capacity Required

<u>Ridership Category</u>	<u>All Local</u>	<u>With Peak Express</u>	<u>Combined Trains</u>
All-Day Boardings at Extension Stations	1,210	1,360	1,150
A.M. Peak Boardings at Extension Stations	1,030	1,155	980
Diversions from Needham Line	145	145	145
Diversions from Other Commuter Rail Lines	510	540	510
Diversions from Other Transit	50	50	50
New Transit Riders on Extension	335	420	275
A.M. Peak New Boardings on Present Needham Line	470	370	75
New A.M. Peak Capacity Needed	1,355	1,380	910
Additional Coaches Needed @ 185 Seats	7.3	7.3	4.9

APPENDIX D - FURTHER DETAILS ON OPERATIONAL ISSUES

Impacts of Millis Extension on Needham Branch

At present, the Needham Branch is mostly single tracked. There is about one mile of double track at the Forest Hills end. There is a 1,950-foot passing siding west of West Roxbury station at the mid-point between Forest Hills and Needham Junction, and a 1,260-foot siding just east of Needham Junction Station. In scheduling trains on this segment, it is necessary to take into consideration the locations at which inbound and outbound trains will meet. In addition, if trains did not all stop at the same stations, departure intervals would have to be arranged to prevent faster trains from overtaking slower ones traveling in the same direction.

At present, of the 16 weekday trains in each direction, eight in each direction must meet one other train while on the Needham Branch, and two must meet two other trains. Of the 12 scheduled "meets," five take place at Forest Hills Station, without delay to either train. The other 7 take place on the double track between Forest Hills and Roslindale or at the West Roxbury or Needham Junction passing sidings. The locations of these meeting points result in scheduled delays ranging from 2 to 13 minutes for each train that goes into the siding. When meets are made in A.M. hours, the outbound train takes the siding; in P.M. hours the inbound train takes the siding. This minimizes passenger delays, because most off-peak direction trains on this line are lightly patronized.

Increasing the number of trains using the Needham Branch, especially during peak hours, would require more meets between inbound and outbound trains, and would increase the average delay for trains taking sidings. The added delays would interfere with trains making their next scheduled departures in cases where scheduled turnback time at Needham Heights or South Station is already close to the minimum possible.

If Millis service were provided entirely by adding Millis sections to Needham Heights trains that would be running anyway, the total number of trains running between Needham Junction and Forest Hills would be unchanged. As explained below, however, it would not be possible to maintain the existing schedules of all trains.

A locomotive-propelled train used in push-pull service,¹¹ as all MBTA trains currently are, requires a minimum time allowance of about 10 minutes to reverse direction after arriving at the end of a trip. (Most of this time is occupied in performing a mandatory air-brake test after the engineer has walked from one end of the train to the other.) Self-propelled cars could be expected to require a similar minimum allowance. According to estimates in the New Bedford/Fall River commuter rail study, adding or removing cars at an intermediate station would lengthen the stop time by at least 7 minutes because of brake tests. Therefore, the only trains that could retain their existing

¹¹A train in push-pull configuration can be operated either from the locomotive (pull mode) or from an engineer's cab in the coach at the opposite end of the train (push mode).

schedules in both directions on the Needham Branch would be those that now have scheduled layovers of at least 17 minutes at the terminals.

Currently, of 13 trains that are scheduled to turn from outbound to inbound trips at Needham Heights, only one has a scheduled layover time of more than 17 minutes; seven have only the minimum 10-minute allowance. Therefore, combining Needham Heights and Millis trains would require that most trips leave Boston earlier or arrive at Boston later than at present. The changes would have to be made in a manner that would not create conflicts between inbound and outbound schedules on single-track segments.

Schedules of all trains would also need to be arranged to prevent local trains from being overtaken by express trains. Under the schedules assumed for purposes of analysis, a train running non-stop from Hersey to Ruggles with no delays and a top speed of 60 m.p.h. on the Needham Branch would pass Forest Hills 9 minutes after leaving Needham Junction. A train running in local service would reach Forest Hills 20 minutes after leaving Needham Junction. With alternating local and express departures every 15 minutes, each local train would be only four minutes ahead of the following express at Forest Hills. This could necessitate some modifications to the signal system. Most Needham Line trains running in the same direction are currently separated by more than 30 minutes, so express trains leaving at the mid-point of the headway would start more than 15 minutes behind the preceding trains.

Impacts of Millis Extension on Route North of Forest Hills

Between Forest Hills Station and South Station, Needham Line trains run via the Amtrak New Haven to Boston, or NHB, Main Line. This route segment has three tracks, which Needham Line trains currently share with commuter trains from the Franklin and Attleboro/Stoughton lines, and with Amtrak intercity passenger trains from New York City and points south. From west to east, the three tracks are identified as Tracks 3, 1, and 2. North of Forest Hills, Track 2 is normally used only by inbound trains, but Tracks 1 and 3 are both used in both directions.

A Millis extension served entirely by adding Millis sections to existing Needham Line trains would not change the total number of peak-period trains using the shared tracks. As discussed above, the additional running time resulting from adding or dropping cars at Needham Junction would necessitate many changes in Boston arrival or departure times of Needham Line trains. These changes would have to be compatible with schedules of other trains on the shared tracks. A Millis extension with separate trains running on the same frequency as present Needham Heights trains with no reduction in the latter would double the number of peak-period Needham Branch trains using the NHB Main Line.

As of May 1997, the segment of the NHB Main Line between Forest Hills and South Station was used by scheduled totals of 37 trains between 6:30 and 9:30 A.M. and 37 between 4:00 and 7:00 P.M. on weekdays. This was an average of four trains per track

per hour. Overall use was less than the combined theoretical capacity of the three tracks, but the available time slots would not all be optimal for a schedule with alternating local and express trains from the Needham Line. The frequency of other trains using the shared line will increase following completion of Amtrak's Northeast Corridor Electrification project, scheduled for 1999. Planned commuter rail trains from New Bedford and Fall River may also be routed over this line.

The Forest Hills Station has one island platform. The east side serves trains on the NHB Main Line Track 3, usually used by inbound Needham Line trains. The west side of the platform serves a track usually used by outbound Needham Line trains (Track 5). This track diverges from Track 3 at a point known as Plains, 0.5 miles north of Forest Hills. There are no platforms for NHB tracks 1 or 2 at Forest Hills. It is possible for trains on any route to stop at Forest Hills if they are running on Track 3, but only Needham Line trains have been scheduled to stop there since the present station opened.

Inbound Needham Line trains usually approach Forest Hills station on the more easterly of the two tracks on the Branch (Track 4) which joins Track 3 just south of the platform. The majority of Needham Line trains in both directions use Track 3 all the way from Forest Hills to Back Bay, but some cross between Track 3 and Tracks 1 or 2 at Plains. In cases where inbound and outbound trains are scheduled to meet at Forest Hills they use different tracks between there and Back Bay to prevent delay of the inbound train by a late arrival of the outbound.

The feasibility of adding Millis trains to the NHB Main Line would need to be determined by a more detailed analysis than was possible for this study. If capacity of that line was found to be insufficient, it would be possible to route some trains from the Attleboro/Stoughton or Franklin lines via the Dorchester Branch (Fairmount Line) between Readville and South Station. As of May 1997, this two-track line was used by only 13 trains between 6:30 and 9:30 A.M. and 14 between 4:00 and 7:00 P.M., leaving substantial additional capacity.

The main disadvantage of a Dorchester Branch routing is that it bypasses Back Bay and Ruggles stations, making service less convenient for many passengers. (Alighting counts taken in conjunction with the 1993 commuter rail survey showed that 40% of Franklin Line passengers and 43% of Attleboro/Stoughton Line passengers on A.M. peak trains alighted at Back Bay or Ruggles.) The fastest scheduled running times between Readville and South Station on the Dorchester Branch are currently slightly less than the fastest times on the Attleboro/Stoughton Line (18 minutes versus 19) despite lower maximum speed limits on the Dorchester Branch (60 m.p.h. versus 80 m.p.h. for commuter trains). This is possible because of the half-mile shorter distance and the omission of Back Bay and Ruggles dwell times on the Dorchester Branch.

Impacts at South Station

Millis trains would have South Station as their Boston terminal. South Station currently has 13 tracks. Service on the Old Colony Lines, which began in September 1997,

requires the exclusive use of two of these. This leaves 11 tracks to be shared by all other commuter and intercity trains using the station.¹² Track layout allows access to all station tracks from all entering routes, but not all platforms are suitable for all trains. Because of the irregular shape of the station, platform lengths are not uniform, and capacities range from 6 to 14 cars.

The number of tracks needed to serve all routes using South Station depends on the service frequency on each route and on the length of time that each train is in the station. All tracks end at the station, so all trains must reverse direction between arrival and departure. A train in the station may turn from an inbound to an outbound revenue trip, arrive from the yard and depart on a revenue trip, or arrive from a revenue trip and proceed to the yard. Regardless of which of these is the case, a train in the station usually occupies a track for a minimum of 10 minutes. Including time to enter and leave the station, a train effectively occupies a track for at least 15 minutes, resulting in a maximum capacity of four trains per track per hour. Schedules often call for trains to remain in the station longer than the 10-minute minimum because inbound arrivals times cannot all be matched that closely with scheduled departures. Trains going to the yard may have to wait in the station until yard space is clear or until a switching crew is available.

Under the schedules in effect in May 1997, there were 38 scheduled train arrivals in South Station between 6:30 and 9:30 A.M., or an average of only 1.1 arrivals per hour per track. Throughout most of this span, the number of tracks occupied simultaneously did not exceed seven. There was, however, a brief time around 9:00 A.M. when 11 tracks would all be occupied (excluding the two Old Colony tracks). Between 3:30 and 6:30 P.M. there were 36 scheduled departures. The number of tracks occupied simultaneously seldom exceeded seven, but 11 tracks were in use briefly around 4:30, and 10 tracks were in use around 5:00. These conditions imply that South Station could accommodate a greater number of trains than it does at present even with the addition of Old Colony Lines service, but a more detailed analysis would be needed to determine how well the available time slots match the needed arrival and departure times of new trains.

¹²Two of the 13 tracks were added in conjunction with the Old Colony restoration. They are not normally required for present service on other lines, but are sometimes used when construction work blocks other tracks in the station.

APPENDIX E - ANALYSIS OF ALTERNATE STATION LOCATIONS

Role of Walk-In Potential in Station Site Selection

In the 1993 commuter rail survey, among passengers who reported walking as their mode of access to the outer boarding station, 96 percent reported access times of 20 minutes or less. At typical walking speeds, this would mean that most walk-ins had access distances of under one mile. As will be seen from the discussion below, the number of potential users of a Millis commuter rail extension who would live within one mile of a station would be relatively small. Trip origins would also be too widely scattered to allow for cost-effective feeder services. Therefore, in planning stations for the extension, highway access and parking availability would be of greater importance than walk-in potential.

As discussed in Chapter 4, home-to-work trips ending in either Boston or Cambridge account for 85% of the inbound weekday ridership on the existing commuter rail lines terminating at South Station. Work trips to the Boston Central Business District alone account for 74% of the ridership. It is reasonable to assume that Boston and Cambridge work trips would also be the primary market for a Millis commuter rail extension. Journey-to-Work figures from the 1990 Census show that under 5% of the residents of Medfield, Millis, or Medway worked in Boston Proper. For Dover, the figure was 7.3%, and for Sherborn it was 6.2%. Of the five towns, only Dover and Sherborn had over 10% of their residents employed in all of Boston or Cambridge. Dover and Sherborn also had the two lowest population totals of the five, however.

A circle with a radius of one mile centered on a rail station, representing the walk-in attraction area, would have a total area of about three square miles. If population distribution were uniform, such a circle drawn in Dover would have enclosed an average of about 125 Boston or Cambridge workers in 1990. Actual population density is higher than the town-wide average in the area surrounding the Dover station site, but the number of Boston and Cambridge workers living within one mile of the station probably did not exceed 250. Overall growth of 34% is projected between 1990 and 2020, but this is likely to be concentrated in areas further from the station where land is now less developed.

In Medfield, with uniform population distribution, a one-mile circle would have enclosed about 225 Boston or Cambridge workers in 1990. The Medfield Junction station site is in an area of below-average population density, however. Overall population growth of 24% is projected between 1990 and 2020. Much of the area within one mile of the station site is currently zoned for industrial rather than residential development, and some is unbuildable because of wetlands.

In Millis, with uniform population distribution, a one-mile circle would have enclosed about 160 Boston or Cambridge workers in 1990. Population density in the vicinity of The Clicquot station site is somewhat higher than this average. Overall population growth of 17% is projected for the town between 1990 and 2020. This is likely to occur

largely beyond a one-mile radius of Clicquot because of the amount of existing development.

Most of the analysis in this study is for an extension terminating at Clicquot, but an alternate terminal at Route 109 is discussed later in this appendix. Population density around the Route 109 site is substantially lower than that around Clicquot. Much of the vacant land within one mile of the Route 109 site is a swamp.

A further extension of the Millis Line to West Medway is discussed in appendix F. In Medway, with uniform population distribution, a one-mile circle would have enclosed about 110 Boston or Cambridge workers in 1990. The West Medway station site is in an area of higher population density, but the number of Boston and Cambridge workers living within one mile of the station site probably did not exceed 200. Overall population growth of 46% is projected for the town between 1990 and 2020, but this is likely to be concentrated in the less-developed areas more than one mile from the West Medway station site.

Not all Boston or Cambridge workers living within one mile of any station site would use commuter rail, and not all of those who did use commuter rail would be willing to walk to the station. As discussed in chapter 6, ridership on a Millis extension under any of the alternatives examined would result in a relatively low ratio of incremental revenue to incremental operating cost. Ridership accounted for by walk-ins at any potential station site would, in turn, account for less than half of the estimated total boardings.

Identification of specific station sites on a Millis commuter rail extension is beyond the scope of this study. For purposes of analyzing ridership, travel times, and traffic impacts of the extension, however, it was necessary to make some assumptions about approximate station locations. The following sections of this appendix discuss characteristics of past station sites on the line, and of new sites suggested in prior studies. Future station locations would not necessarily correspond with any of these.

General Characteristics of Past Stations on Millis Line

None of the past station sites on the Millis Line between Needham Junction and Millis (or further west) have any remains of platforms, lighting, or parking facilities that would be suitable for future rail passenger service, so construction costs would be similar at these sites or at entirely new ones. Most of the past stations were located when the rail lines were constructed in the 1800s. Access then would have consisted mainly of walk-ins with some drop-offs by horse and carriage, so there was no reason to provide for all-day vehicle parking. Traffic levels on the lines never grew sufficiently to call for major station modernization. Off-street parking at stations consisted at best of a few unpaved spaces.

Locations of Past Millis Line Stations

Historically, when passenger service was operated on the Millis there was one station in Needham (excluding those on the present Needham Line), one station in Dover, and two each in Medfield, Millis, and Medway. (See map on page 13.) Charles River Station was on the south side of Charles River Street in Needham. For reasons discussed in the first section of chapter 2, it is assumed that a future Millis extension would not have any stations in Needham west of Needham Junction. The Dover Station was on the north side of Dedham Street. For purposes of analysis, the future station site was assumed to be one block to the south of this, at Springdale Avenue, because there is more room for parking there. The difference in locations between these two sites would be insufficient to affect the demand forecasts.

In Medfield, Farm Street station was on the north side of the street of that name, and Medfield Junction Station was off Mill Street north of Route 27. For reasons discussed in chapter 3, it was assumed that there would be no station at Farm Street on a future extension. The former Medfield Junction site was assumed to be the approximate location of the future station for Medfield.

In Millis, Clicquot station was on the west side of Union Street. This is one of the two station location alternatives for Millis analyzed in this study. The old Millis Station was west of Exchange Street. It was assumed that this site would not be used for a future station, because the historic station building now serves as town offices, and because there is no room for parking there. The Route 109 station site examined in this study is in a location where there was never a station in the past.

In Medway, the Medway Station was between Barber and Broad streets. A future station there was not analyzed in detail. There is insufficient room for parking at this site, and walk-in and drop-off potential alone would be insufficient to justify a station there. The West Medway Station was on the west side of the bridge at Village Street. In appendix F, this was assumed to be the location of the future station for Medway if the line were extended further than Millis.

Proximity of Potential Station Sites to Major Highways

No limited-access highways pass directly through Dover, Medfield, Millis, or Medway. Dover has no numbered state highways of any kind, but Centre Street, which parallels the rail line through the town, is comparable to many secondary state highways. Centre Street intersects Springdale Avenue about 750 feet from the assumed Dover station site.

State Route 109 runs through Medfield, Millis, and Medway, paralleling the rail line at varying distances. This is part of one of the main driving routes between these towns and Boston. In Medfield, the shortest driving distance between Route 109 and the Medfield Junction station site is about 1.4 miles.

In Millis, the Clicquot site is about 0.2 mile from Route 109. The alternate station site in that town would be directly at Route 109. On a further extension beyond Millis, the West Medway station site would be about 0.4 mile from the nearest point on Route 109.

Medfield, Millis, and Medway also each have one state highway oriented for circumferential travel. In Medfield, Route 27 passes within 0.5 mile of the Medfield Junction site. In Millis, Route 115 passes within 0.4 mile of Clicquot and within 0.8 mile of the Route 109 site. In Medway, Route 126 passes within 1.0 mile of the West Medway station site. Each of these highways connects the Millis Line corridor with several other towns. Route 27 would be the main access route to the Medfield Junction station from Sherborn. For reasons discussed in chapter 2, ridership attracted to a Millis extension from any other towns along routes 27, 115, or 126 would be negligible.

Further Discussion of Clicquot versus Route 109 as Millis Station Site

The 1988 feasibility study of commuter rail service restoration on the Millis line identified Clicquot as a likely site for a Millis Station, with the Route 109 site being a second choice. Although identification of specific station locations was beyond the scope of the present study, for purposes of analysis, the Clicquot and Route 109 sites were evaluated as separate alternatives. The differences between the two sites were found to be relatively small. In almost every measure, however, the Clicquot site was found to be the better of the two, as summarized below. (Only the results with a Clicquot terminal were included in the main body of the report.)

A Millis station would be used mostly for trips originating in Millis or Medway, with Millis being slightly more important of the two (see Tables 4-1 and 4-2). The Clicquot site is at the approximate population center of the town, and most town residents could access it without backtracking compared with driving routes to Boston. In contrast, the Route 109 site is further west than most homes in Millis, so most residents would have to backtrack to reach it.

Medway residents would all have to travel further to a Clicquot station than to a Route 109 station, and most would have to go directly past the Route 109 site to reach Clicquot. Only a very small number of Medway homes would be within walking distance of even a Route 109 station, however, so almost all Medway residents would rely on some form of auto access to either station. Given this requirement, the additional driving distance of about 1.3 miles to Clicquot would have little impact on ridership originating in Medway.

The rail running times to Boston from a Route 109 terminal would be about two minutes longer than that from Clicquot. The present express bus time to Boston from the stop nearest a Route 109 rail station site (Pleasant Street) is also two minutes longer than the time from the stop nearest Clicquot.

An extension to Route 109 would be 1.2 miles longer than an extension to Clicquot. Most of the track between the two sites is still in place and used for freight service, but it would need to be completely rebuilt for passenger service. About one quarter mile of track beyond the present end of freight service and the Route 109 site has been removed. Part of the right-of-way has been sold, and a portion of an earth embankment that formerly carried the track there has been removed. Excluding the cost of rebuilding the embankment, the cost of rebuilding the track and installing signals between Clicquot and Route 109 would be about \$3,425,000.

Within this segment there are two public road crossings and one private crossing. The cost of new surfacing and automatic lights at the two public crossings would be about \$410,000. Additional fencing needed for this segment would cost about \$15,000.

There are no track bridges between Clicquot and Route 109. One road bridge crosses the track, but it would not require any improvements for passenger service that would not otherwise be needed to maintain the existing freight service on the line. A Route 109 station would be instead of rather than in addition to a Clicquot station. Site-specific differences in design that might affect station construction cost are beyond the scope of this study, so no difference in cost of platforms and shelters was assumed for the two Millis terminal alternatives. The demand forecasting procedure was not sufficiently sensitive to station location to indicate a difference in ridership between the two sites. The Route 109 location would be somewhat more dependent on auto access because of its greater distance from most homes in Millis, but additional parking requirements at Route 109 have not been calculated. Differences in ridership and in equipment cycling time between Clicquot and Millis terminals would be insufficient to affect rolling stock requirements.

The costs enumerated above for tracks, signals, crossings, and fencing between Clicquot and Route 109 in Millis total \$3,850,000. Allowances for contingencies, engineering, administration, and inspection would bring the cost of this additional extension to \$4,785,000. This difference would apply to all service alternatives analyzed.

Of the Clicquot terminal service alternatives shown in Table 9-1, peak-period Express service with off-peak Local service would have the lowest capital cost per new transit rider, at \$94,523. Express/Local service to Route 109 would not change the number of riders, but would raise the cost per new rider in the year 2020 to \$98,562. This would still be less than the cost of any of the other Clicquot alternatives shown in the table. (With Local service only, the cost per new rider with a Route 109 terminal would be \$117,455, compared with \$111,495 for a Clicquot terminal.)

With either all Local or Express and Local service, the extra train mileage to Route 109 compared with a Clicquot terminal would increase operating cost of Monday through Saturday service by \$530,000 per year. For push-pull trains combined with Needham Heights trains between Needham Junction and Boston, the added operating cost to Route 109 would be \$375,000. For DMU cars running in Combined trains east of Needham Junction, the extra cost to Route 109 versus Clicquot would be \$245,000.

Since revenue would not be affected, each Route 109 alternative would have a lower revenue-to-cost ratio than that of the corresponding Clicquot alternative.

As discussed in chapter 8, an extension terminating at Clicquot would not have a direct impact on any community or cultural resources within that town. An extension to the Route 109 site would pass the former Millis railroad station, which is a registered historic landmark and now serves as town offices. A rail line would, however, be consistent with the original purpose of this building. A Route 109 extension would also run along the borders of Centennial Park (a small recreation area) and the Prospect Hill Cemetery and would pass within 200 feet of the town library. The segment between Clicquot and Route 109 would also pass within 200 feet of about 40 houses, compared with about 10 between the Medfield-Millis town line and Clicquot.

The main advantage of a Route 109 terminal compared with Clicquot would be the greater amount of present vacant land at Route 109. Proximity to Great Black Swamp could limit development of the Route 109 site, however.

With a terminal at Route 109 in Millis instead of at Clicquot, VMT reductions would be slightly greater, but train emissions would increase. The net result would be that air quality benefits would be slightly lower with a Route 109 terminal.

The segment between Clicquot and Route 109 has two public road crossings. Traffic counts have not been made at these crossings, but neither of them appear to be heavily traveled ways. With a terminal at Route 109, trains crossing the private driveway to the Devco Products plant could cause traffic approaching the plant to back up onto Route 109.

APPENDIX F - ANALYSIS OF FURTHER EXTENSION OF COMMUTER RAIL SERVICE BEYOND MILLIS

Summary

As discussed elsewhere in this report, the rail line to Millis formerly continued west through Medway, Bellingham and Blackstone to Woonsocket, Rhode Island. Segments beyond Millis were abandoned at various times beginning in 1934, with the most recent abandonment being that between Millis and West Medway in 1967. Much of the right-of-way beyond the present end of track in Millis has been sold to private owners.

The work program for the present study called for an analysis of a commuter rail extension as far south as Millis. The 1988 study (cited on page 15) examined an extension on the same route, but continuing beyond Millis to Medway and Bellingham. This appendix examines issues involved in an extension beyond Millis. The first section summarizes legal issues pertaining to the status of this segment of the line. This is followed by the results of a field inspection of the segment from Millis to West Medway conducted by CTPS in 1997. Much of the former roadbed is badly deteriorated, but there appear to be no insurmountable obstacles to restoration of rail service as far as West Medway if this should otherwise prove to be the best alternative. As shown in the final sections of the appendix, however, even if the right-of-way in question were in good condition, a commuter rail extension using it would rank low in all the cost-effectiveness criteria used. Beyond West Medway, the former right-of-way has been obliterated to such an extent that any future rail line there would have to be built at least in part on a new alignment.

Background of Abandonment and Partial Sale of Right-of-Way

The last operator of each of the abandoned segments of the Millis Line west of Millis was the New York, New Haven and Hartford Railroad (New Haven Railroad). Because of serious financial problems, the New Haven abandoned many unprofitable branch lines in eastern Massachusetts beginning in the 1930s. The southern end of the Millis Line was among these. It was cut back from Woonsocket Junction (near the state line) to Bellingham Junction in 1934, to Caryville Station in Bellingham in 1941, and to West Medway in 1949. After passenger service was discontinued between Millis and West Medway in 1966, there was insufficient freight traffic to sustain that portion of the line, so it was abandoned the following year.

Each of the abandonments of part of the Millis Line was implemented with the required approval of the Interstate Commerce Commission (ICC). Under laws in effect when these abandonments were approved, the New Haven was free to remove the track and to sell the right-of-way to any interested buyers. South of Bellingham Junction most of the right-of-way was too far removed from developed areas to attract buyers, so it survived as a dirt trail. Between Bellingham Junction and West Medway, however, much of the right-of-way had been obliterated by new housing developments by the mid 1960s.

In December 1968, all of the assets of the New Haven Railroad, including active rights-of-way and abandoned rights-of-way not previously sold, were acquired by the Penn Central Company. In 1971, Penn Central agreed to sell 146 miles of active and abandoned rights-of-way, consisting mostly of former New Haven lines, to the MBTA. The portion of the Millis Line between Needham Junction and the end of track in Millis was included, but none of the abandoned right-of-way further to the west was.

The Massachusetts legislature subsequently enacted two statutes intended to help preserve former rail rights-of-way. Chapter 963 of the Acts of 1973 provided that no municipality could issue a building permit for a structure to be built on lands formerly used for railroad rights-of-way or property appurtenant thereto without holding a public hearing and without receiving written permission from the secretary of the Executive Office of Transportation and Construction (EOTC).

Chapter 859 of the Acts of 1975 contained a section providing that no railroad company could sell or dispose of rights-of-way in the Commonwealth without first offering the same for sale to EOTC or a public agency designated by EOTC. Upon receipt of any such offer, EOTC was required to act on it within 90 days in order to retain the first right of purchase.

In 1976, Penn Central ceased to be an operating railroad company. Most of its active rail lines were transferred to Conrail, but the Penn Central Corporation retained ownership of previously abandoned rights-of-way as well as several lines not included in the Conrail system.

In 1982, the Penn Central Corporation, pursuant to the terms of Chapter 859 of the Acts of 1975, offered the abandoned right-of-way between the end of track in Millis and the Medway town line for sale to EOTC in three parcels. These were from end of track to Route 109, Route 109 to Cedar Street, and Cedar Street to town line. EOTC declined to purchase these parcels or to designate another public entity to purchase them, so all three were sold to private parties the same year. Further investigation would be needed to determine if there have been subsequent transactions involving this property.

Between 1982 and 1985, the town of Medway purchased the abandoned right-of-way in that town between the Millis town line and Village Street from Penn Central in several separate transactions. As of September 1996, the Medway Board of Selectmen was exploring possibilities for creating a bicycle path on this segment. (As discussed below, title to part of this property is being challenged in land court.) The town also purchased several discontinuous segments of right-of-way between Village Street and the Bellingham town line. These are separated by parcels previously sold to private parties, limiting their possible use for future transportation purposes.

Results of Right-of-Way Inspection, Millis to West Medway

In May 1997, an inspection of the former Millis Line right-of-way between the end of track in Millis and the former West Medway station site was conducted by the CTPS

project manager for this study. This entire segment was walked. A further inspection of the former rail location between West Medway and the Bellingham town line was made by observations at locations where the right-of-way would have crossed present street locations. The findings were as summarized below, starting from the Millis end. (In this section, the direction from Millis to West Medway is referred to as west, although the actual compass heading is generally southwest.)

At present, track on the Millis Line ends west of the access road to the Devco Products industrial plant, near the intersection of Pleasant Street and Route 109. There, an active side track to the Devco plant diverges from the former main line. This location is 0.4 miles west of the old Millis Station site. The Devco access road is crossed at grade, with protection only by signs. There is also a grade crossing of Auburn Road between the old station and the Devco road, also protected only by signs.

West of the Devco siding, the railroad crossed a long earth fill about 10 feet high. A large quantity of discarded ties and fallen trees obstruct the right-of-way there. Approaching the former grade crossing with Route 109, the fill has been completely removed for a distance of about 500 feet. In this area the railroad and the highway were nearly parallel, requiring an oblique crossing angle. A grade crossing with the present highway alignment would be over 500 feet long. Some change in the highway may have been made since the railroad was abandoned.

Between the Route 109 crossing (0.7 miles from Millis Station) and the Medway town line, the right-of-way is mostly intact, but is prone to flooding because of poor drainage in cuts. This section has no public grade crossings. A section of Cedar Street which formerly crossed at grade 1.2 miles west of Millis Station is no longer maintained and is now just an unpaved footpath. Future development could result in reactivation of this road, however.

At 1.5 miles west of Millis Station, a private crossing extending north from the end of Alma Road provides access to one house. A short distance west of this, a section of rock fill about 10 feet deep and 160 feet long has been removed. At the Millis/Medway town line 1.7 miles west of Millis Station, several large boulders have been placed across the right-of-way to block vehicular access.

Between the Millis town line and Oakland Street (2.1 miles from Millis Station) the right-of-way is relatively clear. It is used informally, but not heavily, as a hiking and horseback riding trail. (No trail users were seen anywhere along the right-of-way during the inspection.)

The Oakland Street crossing was at grade. Immediately to the west side of this crossing, the former track location is difficult to distinguish from that of an adjacent unpaved driveway to a house. Old maps and crossing lists show the driveway making two grade crossings with the railroad about 200 feet apart. If rail service were restored, the driveway should be relocated to eliminate these crossings.

For about one quarter mile east of Barber Street, (2.5 miles from Millis Station) the right-of-way is now used as the access road to one house and to an active gravel pit and a brush disposal area. Rail restoration would require construction of a new access road to these sites if they were to remain in their present uses.

Barber Street was formerly crossed at grade, and was a private way at that point. It is the access road to the Oakland Cemetery, which abuts the right-of-way to the north. The former Medway Station was located between Barber Street and Broad Street, 0.1 miles further west. A large pile of old pavement fragments and other rubble blocked the right-of-way at the station site at the time of the inspection. Broad Street crossed the railroad at grade, as a private way.

West of Pine Street, which formerly had a private grade crossing of the railroad, the right-of-way entered a long earth cut approaching Holliston Street (2.8 miles from Millis). The street formerly crossed the railroad on a bridge, which has been removed and filled in. This has resulted in flooding of the roadbed on both sides. A recreational trail is located within the former railroad property lines on the east side of the crossing but runs along the top edge of the cut.

The Burke elementary school adjoins the former right-of-way at the north end of Legion Avenue (3.0 miles from Millis). The railroad was in a cut 10 to 20 feet deep at this point. The cut has been filled up to street level for a distance of several hundred feet behind the school grounds. A teachers' parking lot runs up to and possibly partly onto the former cut location. On the day of the CTPS inspection, a major enlargement of the school was under construction. A fenced-in children's play area was located directly on the filled-in cut. A large new playground being graded to the west of the school also extended completely across the former right-of-way location.

As the result of the filling in of the cut at the school, the remainder of the cut west of there was badly flooded. At about 3.4 miles west of Millis, a section of fill about 5 feet high and 600 feet long had been washed away by a brook.

No public roads cross the right-of-way between Holliston Street and the West Medway Station site, but a few dead-end at it. At a point opposite the corner of Cottage and William Streets, a section of the right-of-way the length of one house lot has been fenced in and posted No Trespassing by the abutting property owner. Additional posted notices state that the town's title to this parcel is being challenged in land court on the basis of claimed reversionary rights in the deed to the original railroad company. Just west of this, the railroad was on an embankment, part of which has been removed to create a small picnic area between the right-of-way and Village Street.

The railroad formerly crossed Village Street on a 46-foot-long deck plate girder bridge. Village Street made sharp turns on both sides of the bridge in order to cross at a right angle and minimize the span length. The east abutment of this bridge is still in place, but the superstructure, west abutment, and part of the embankment to the west have all been removed. Village Street has been realigned to cross the former railroad location

obliquely. Because of the difference in railroad and road elevations, a new bridge of some kind would be required on a rail line extending west of this point.

The old West Medway Station site (also assumed as the site of a future station in the 1988 study) was about 500 feet west of the Village Street bridge. This site has been largely obliterated by the regrading for the Village Street realignment.

Results of Right-of-Way Inspection, West Medway to Bellingham Town Line

Between the West Medway Station site and the Medway/Bellingham town line, an inspection of all roads crossing the former railroad alignment found no obvious traces of the right-of way. (The location was determined from old maps.) When the railroad was still active, there were grade crossings of Campbell, Haven, and Franklin Streets, with the first two being private ways. On the east side of Franklin Street, a long one-story building containing several small businesses now extends across the apparent former railroad location. A steep dropoff in elevation to the east of this building suggests that the former railroad grade has been partly washed out by flooding of the adjoining Charles River.

On the west side of Franklin Street, property maps indicate that the right-of way ran between two lines of houses, one fronting on Village Street and the other on Waterview Circle. The latter street was built after the railroad was abandoned, and now crosses the former railroad location about one quarter mile west of Franklin Street. Several other new streets to developments off Village Street end in cul-de-sacs either on or adjoining the right-of-way.

At the Bellingham town line the right-of-way crossed Hopping Brook on a 12-foot stone arch. The bridge site is inaccessible, so the present status of the bridge was not determined. No attempt was made to inspect the former railroad location further west than the Bellingham town line.

Evaluation of Commuter Rail Extension to West Medway

Given the findings above, it would be difficult, although not impossible, to restore rail service on the Millis Line further west than the Route 109 station site in Millis proposed in the 1988 study. To determine whether the alternative of restoration to West Medway should be pursued further, it was analyzed on the basis of the same considerations applied to the other alternatives examined in this study. The analysis is contained in the remainder of this appendix. The conclusion is that such an extension would not be cost-effective.

Running Times

Historically, the maximum speed limit for passenger trains between Clicquot and West Medway was 35 m.p.h. For purposes of analysis, it was assumed that this would be raised to 60 m.p.h. for future service. At this speed, the running time from a West

Medway station at Village Street to Clicquot with no intermediate stops would be about 6 minutes. Including dwell time at Clicquot, the running time from West Medway to South Station would be about 56 minutes for a local train or 45 minutes for an express. Times to Back Bay would be 5 minutes less.

Comparisons with Travel Times for Other Alternatives

The estimated driving time to Boston from West Medway is 66 minutes to the South Station area, so even a local train would be faster on the line-haul portion of the trip. The scheduled bus time to the South Station area from the stop nearest the West Medway Station site is 67 minutes. On the one trip observed by CTPS, traffic delays added about 7 minutes to this time. Few Medway residents currently use the buses, however.

Passengers boarding a train at West Medway would spend 7 minutes more on board than passengers boarding the same train at Clicquot. Passengers from origins further west than the West Medway station would save about 8 minutes in access time by going to West Medway, or an overall saving of one minute. Passengers with origins east of the West Medway station would have no overall travel time reductions by boarding at West Medway. There are only a few possible driving routes from Medway into Millis, with the most heavily used ones being Route 109 and Village Street. On either of these routes, the distances from the Medway/Millis town line to Clicquot and to West Medway are about equal, so most Medway residents would have shorter access distances to West Medway. This would cause some to use a station there despite longer overall travel times. A station at Route 109 in Millis instead of Clicquot would shift the point of equal access distance 0.6 miles into Medway from the town line, but relatively few homes are within the area that would be affected.

Level of Service

Scheduling considerations for an extension to West Medway would be the same as those for an extension terminating in Millis. Therefore, a West Medway terminal would have no inherent level of service advantage or disadvantage compared with a Millis terminal.

Fares

Based on rail distance from Boston, a West Medway station would be in fare Zone 6, compared with Zone 5 for a station in Millis. At present, the most common commuter rail boarding station for Medway residents is Norfolk, also in Zone 5. Boarding at West Medway would be more costly than boarding at either Millis or Norfolk.

Impact on Ridership

The cost calculations in chapter 5 assume that with a line terminating in Millis, all Medway residents using the line would board at the Millis station. The distribution of

population in Medway is such that some residents would use the Millis station even if there were also a station in Medway. Because of the already high rail share of Boston and Cambridge travel from Medway, total ridership from the town would not increase if there were a station there, but there would be more access by walk-ins or drop-offs and less by park-and-ride. At 1996 travel levels a West Medway station would need about 90 parking spaces for Medway residents, or half the number needed for Medway residents at a Millis station if they all boarded there.

For residents of most towns other than Medway, a West Medway station would be no more attractive than a Millis station, so extending to West Medway would have little impact on the overall market area of the line. The one town possibly added to the market area would be Milford. At present, most Milford residents who use commuter rail board at Forge Park station on the Franklin Line. The average driving time to Forge Park from downtown Milford is 12 minutes, and the average driving time to a West Medway station would also be about 12 minutes. At present, the average A.M. peak scheduled train time from Forge Park to South Station is 62 minutes, with a range from 54 to 67 minutes. The estimated time from West Medway to South Station would be 56 minutes for a local train or 45 minutes for an express. With unconstrained parking, a West Medway station would be likely to divert most of the present 130 Milford riders who now use the Forge Park and Franklin/Dean College Stations if service there remained the same as at present. With allowances for carpooling and for daily ridership variation, about 140 parking spaces would need to be provided at West Medway for Milford residents. The overall improvement in travel time to Boston with either local or express service to West Medway compared with present Forge Park service would be insufficient to attract significant numbers of new transit users from Milford. If direct commuter rail service to Milford were implemented, most Milford residents would find it more convenient than any station on a Millis extension. Express service from Forge Park would also offer Milford residents total travel times nearly as fast as those of express service from West Medway and faster than local service from there.¹³

Impact on Revenue

A West Medway terminal would be in fare Zone 6, but a Millis terminal would be in Zone 5. Most users of a West Medway station would use either the Millis station or a Zone 5 or 6 station on another line if there were no West Medway Station. The average fare paid by Zone 6 passengers is currently about 8% higher than that paid by Zone 5 passengers, so fare revenue from passengers diverted to West Medway from Zone 5 stations would increase correspondingly. As discussed above, the greatest number of these passengers would be Medway residents. Most passengers diverted to West Medway from stations not in Zone 5 would come from Forge Park or Franklin/Dean College Station. These are both in Zone 6, so no change in revenue would result from

¹³A commuter rail extension to Milford from Forge Park and implementation of express service from Forge Park without a Milford extension are discussed the CTPS Milford Commuter Rail Extension Feasibility Study completed in 1987.

passengers shifting from them to West Medway. (Most of these passengers would be Milford residents.) Each of the service alternatives with a West Medway terminal would generate at most about \$20,000 more new revenue each year than the corresponding Clicquot or Route 109 terminal alternative.

Impact on Operating Cost

The difference in operating cost between a Millis extension terminating at West Medway and an extension terminating at Millis would be almost directly proportional to the increase in route-miles operated. Because of insufficient room for a layover facility in Medway, it is assumed that trains would be based at a facility near Clicquot and run between there and West Medway at the beginning and end of their service days. The change in ridership with a West Medway terminal would not be sufficient to affect required train lengths.

A West Medway terminal at the former station site there would be 4.5 miles beyond Clicquot or 3.3 miles beyond Route 109. For either the Local or Express/Local service alternative, a West Medway terminal would increase annual operating cost for daily service by \$2,200,000 compared with a Clicquot terminal or by \$1,625,000 compared with a Route 109 terminal. With service Monday through Saturday only, these differentials would be \$2,015,000 or \$1,485,000. For weekday-only service, operating cost for a West Medway terminal would exceed that for a Clicquot terminal by \$1,805,000 or that for a Route 109 terminal by \$1,325,000.

For the alternative with Millis and Needham Heights trains combined east of Needham Junction using push-pull equipment, a West Medway terminal with daily service would increase annual operating cost by \$1,865,000 compared with a Clicquot terminal, or by \$1,135,000 compared with a Route 109 terminal. With service Monday through Saturday only, these differentials would be \$1,320,000 or \$1,040,000. For weekday-only service, operating cost for a West Medway terminal would exceed that for a Clicquot terminal by \$1,180,000 or that for a Route 109 terminal by \$930,000.

For Combined trains using DMU equipment, a West Medway terminal with daily service would increase annual operating cost by \$980,000 compared with a Clicquot terminal, or by \$715,000 compared with a Route 109 terminal. With service Monday through Saturday only, these differentials would be \$915,000 or \$670,000. For weekday-only service, operating cost for a West Medway terminal would exceed that for a Clicquot terminal by \$835,000 or that for a Route 109 terminal by \$615,000.

Impact on Ratio of Revenue to Operating Cost

Compared with a terminal at Clicquot, the additional revenue for an extension to West Medway would equal no more than 2.1% of the added operating cost. This would occur under the least costly alternative of DMU service on weekdays only. For the most costly alternative of through service to Boston seven days a week, this ratio would be 0.9%. For every service alternative, the overall revenue-to cost ratio of a Millis Line

extension terminating at West Medway would be lower than that for the corresponding alternative for an extension terminating in Millis.

Capital Costs

A terminal at the former West Medway station site would be 3.3 miles further than Route 109 in Millis. At current cost levels, the additional expense for track and signal installation on a prepared roadbed for this distance would be about \$9,435,000. As discussed above, the former right-of-way has been altered in several places, with cuts filled in and sections of embankments excavated or washed out. More detailed engineering studies would be needed to determine the cost of work needed to restore the roadbed for track installation. A preliminary examination indicates that at least \$1,000,000 should be allowed for this work.

This segment would include two grade crossings of public roads and at least four of private roads. Crossing surfaces, lights, and automatic gates for the public roads would cost about \$410,000. Right-of-way fencing totaling about 5,000 linear feet would be needed in this segment, at a cost of about \$35,000.

Between Route 109 and West Medway, the only track bridge over a road was that at Village Street, east of the West Medway station site. Replacement of this bridge on its former location would cost about \$800,000 for the bridge alone. It would, however, be necessary either to return Village Street to its former undesirable reverse-curve configuration or to build a bridge with a much longer span than the one formerly located there. Either alternative would involve substantial additional cost. For purposes of analysis, a total cost of \$3,000,000 is assumed for a bridge at this location.

There were no major water crossings in this segment, but there were several small culverts over brooks. An allowance of \$450,000 should be included to upgrade these to prevent future flooding problems along the right-of-way.

There was one road bridge over this segment, at Holliston Street in Medway. This bridge has been replaced with solid fill. A new bridge at this site would cost about \$1,000,000, excluding the expense of removing the fill.

An extension west of Route 109 in Millis would have one station, at the outer terminal in West Medway. This would not result in any change in the number of stations east of Route 109. At the same cost cited for stations in chapter 5, the cost of a platform, benches, shelters, and lighting at West Medway would be \$1,200,000. After all adjustments for diversions from Millis to Medway, for shifts from driving to walking or drop-off access, and for additional Milford riders attracted at Medway, the total number of parking spaces needed on the Millis Line at 1996 travel levels would be about 50 more with a West Medway terminal than it would with a Millis terminal. The difference would decrease to only about 20 spaces at year 2020 travel levels. The added construction cost for 20 spaces would be about \$85,000. The West Medway station site would also require added land acquisition costs of about \$500,000.

The additional running time from Millis to West Medway would not be sufficiently great to require a change in the number of train sets needed to operate peak-period service. The rolling stock requirements calculated in appendix C and chapter 5 would include enough excess seating capacity to accommodate the additional riders attracted by a West Medway extension.

With allowances for contingencies, engineering, administration, and inspection, the capital cost of an extension to West Medway would exceed that of an extension to Route 109 in Millis by at least \$21,150,000 for each service alternative. As discussed in appendix E, the capital cost of an extension terminating at Route 109 in Millis would exceed that with a Clicquot terminal by \$4,785,000. This would make the added capital cost for a West Medway extension compared with a Clicquot extension \$25,935,000.

A West Medway extension would attract no new transit riders not attracted by an extension terminating in Millis. (Additional riders at West Medway would be diverted from other commuter rail service.) Therefore, with a West Medway terminal, the capital cost per new transit rider for the project as a whole would increase significantly. As shown in Table 5-1, of the alternatives with a terminal at Clicquot, Express/Local service would have the lowest capital cost per new transit rider, at \$94,523. A further extension to West Medway with the same service would increase this by 23%, to \$116,409.

Environmental and Community Impacts

Air Quality Impacts

Compared with a terminal at either Clicquot or Route 109, a terminal at West Medway would require fewer Medway residents to use some form of automobile access, and average access distances for all Medway passengers would be reduced. Milford residents diverted to West Medway from Franklin Line stations would also have shorter access distances. Consequently, the weekday VMT reduction for a West Medway terminal would exceed that for a Clicquot terminal by up to 1,320 with Local service, up to 1,345 with Express/Local service, or up to 1,275 with Combined Millis and Needham Line trains. (These figures could be smaller depending on the number of Medway residents choosing to board at Clicquot rather than West Medway.) At the same time, the additional rail distance from Clicquot to West Medway would increase weekday train miles by about 10% with Local or Express/Local service and by nearly 50% under the Combined service alternatives. Train emissions would increase correspondingly. The net impact would be somewhat larger reductions in CO, but smaller reductions in VOC and larger increases in NOx and PM than for an extension to Clicquot.

Impacts on Community and Cultural Resources

Along the portion of the railroad right-of-way between Route 109 in Millis and the Medway town line, no community or cultural resources, as defined in chapter 8 of this study, would be impacted by a commuter rail extension. (Impacts between Clicquot

and Route 109 are discussed in appendix E). Much of the land along the right-of-way in Medway is undeveloped, but at Legion Avenue the line ran directly past the recently enlarged Burke elementary school. As noted above, the railroad bed at that point was in a cut, ranging up to 20 feet in depth, which has been filled in. This cut would have to be re-excavated to restore the railroad. Impacts on the school could be reduced by installing a deck over at least part of the cut. The Medway Junior/Senior High School and Middle School are all located on the north side of the right-of-way in the same area. The school buildings are all at least 600 feet from the former cut location, but athletic fields run directly up to it. At Barber Street, the right-of-way runs along the south edge of the Oakland Cemetery.

Traffic Impacts of Station Access

Under either the Local or Express/Local service alternative, the most heavily used train at a West Medway station would have up to 65 riders arriving by some form of auto access. At this volume, auto arrivals in the final minutes prior to train departure would average about 7 per minute, but not all of these would approach the station from one direction. Because of diversions to the West Medway Station, auto arrivals for the peak train at the Millis station would decrease to about 55 instead of the 100 that would be attracted if the line terminated there.

Grade Crossings

The rail line between Millis and West Medway formerly crossed Route 109 at grade in Millis. This is a two-lane undivided road, but because of the oblique angle between the highway and the railroad, the total crossing length was over 500 feet. Including time for gates to be lowered and raised, a train going over this crossing at the maximum assumed speed of 60 m.p.h. would block it for at least 45 seconds.

Traffic counts on Route 109 at the Medway/Millis town line and at Route 115 in Millis consistently show about 16,000 to 16,500 vehicles per day during the past decade. Informal observations in the vicinity of the crossing site indicate that traffic is almost continuous even during off-peak hours. This could require grade-separation of the crossing for a future rail extension, incurring additional capital costs.

In Medway, all of the grade crossings of the right-of-way were of local roads. When the rail line was still active, only the Oakland Street crossing was listed as a public way. Traffic counts are not available for any of these roads, but none of them appear to be heavily traveled.

Impacts on Abutters

In Millis, most of the land along the right-of-way between Route 109 and the Medway town line is either undeveloped or is used for commercial purposes. At the end of Alma Road three houses are within 200 feet of the former track location, including one that is accessible only by a private grade crossing.

Much of the land along the right-of-way in Medway is also undeveloped, but about 50 houses are within 200 feet of some part of the line within the town. Medway is projected to have population growth of 46% between 1900 and 2020. Some of this growth is likely to occur in the vacant land along the railroad route.

APPENDIX G - RIDERSHIP ESTIMATION METHODOLOGY

Chapter 4 of this report describes the travel markets expected to be served by a Millis extension and summarizes the predicted ridership from these markets. This appendix provides further details on the methods that were used in estimating ridership.

Extension Share of Boston Proper Work-Trip Market at 1990 Travel Levels

The share of the Boston Proper work-trip market captured by the existing commuter rail lines varies widely among the cities and towns served. These differences can be attributed to many underlying causes, but are influenced strongly by the range of options available to residents of these communities. In general, among cities and towns with direct commuter rail service, the highest rail market shares are found where average rail travel speeds are highest, highway access to Boston is poorest, no other direct transit alternatives are available, and rail access is unconstrained by parking capacity. Rail typically also attracts higher market shares as travel distance from Boston increases.

A Millis extension would be a branch of the Needham Line. Trains on the Needham Lines terminate at South Station and also serve Back Bay. Most Needham trains also stop at Ruggles Station, and it is likely that most Millis extension trains would stop there also.

As shown in Table 3-1, a Millis extension with express service would provide faster line-haul travel times than driving to Boston from any of the three towns on the line. As a result, the shares of the Boston work-trip market from these towns that the extension would capture should be among the highest now found on the commuter rail system. The total amount of travel to Boston from these towns is relatively low, however, and much of this travel is already being done via commuter rail. Therefore, the potential of the extension for attracting new transit riders is limited. As discussed in chapter 2, because of the proximity of the Millis extension corridor to other commuter rail lines, virtually all riders using the extension would have trip origins either in one of the three towns served directly or in the adjoining towns of Medway and Sherborn. Like, Millis, Medfield and Dover, Medway and Sherborn originate relatively few trips to Boston, and a large proportion of these are already being made by commuter rail.

Based on Census and survey data for communities on existing MBTA commuter rail lines, a Millis extension with peak-period express service and unconstrained parking could be expected to capture up to 75% of the work trips to Boston Proper from Millis and Medfield and up to 60% from Dover. The 1990 Census results show a total of 220 work trips to Boston Proper from Millis, 465 from Medfield, and 360 from Dover. Applying the shares above would result in a total of 730 of these trips being captured by the extension. Survey results indicate that about 530 of the Boston Proper work trips from these towns are already being made by commuter rail or other mass transit alternatives. Present mass transit users would be among the most likely travelers to shift to the extension, and it would be impossible for the extension to achieve mode

shares as high as those assumed unless all or nearly all of the present mass transit users were diverted. Therefore, only about 200 of the Boston Proper work trips from these towns would represent new transit users.

In general, commuter rail captures smaller shares of trips from cities and towns without stations than from those with direct service, but there are exceptions. These are most likely to occur in cases where direct transportation service to Boston by modes other than rail is inconvenient but there is good access to a rail station in a nearby town. These conditions would apply in Medway, one of the two towns that would be in the Millis extension service area without having a station within its borders. The 1993 survey results indicate that commuter rail was already capturing about 100 of the 130 Boston Proper work trips from Medway, or about 77%. For purposes of analysis, it was assumed that these riders would shift to the Millis extension, but that no additional Medway riders could be attracted.

At present, most Sherborn residents who use commuter rail board at one of the stations on the Framingham/Worcester Line. An analysis of travel times from points in Sherborn and of population distribution in that town indicates that no more than 20% of town residents would find a Millis extension with express service more attractive than Framingham/Worcester Line service. With planned expansion of express service on the latter line, the two routes together could be expected to attract about 55% of Boston Proper work trips from Sherborn, but at most 11% would use the Millis Line. Added to the volume from the three on-line towns, ridership from Medway and Sherborn would make a total of 855 work trips to Boston Proper served by the extension, including 200 new transit users.

Without express service, a Millis extension would still have faster travel times to Boston than driving from Millis or Medfield. From Dover, rail time would be almost the same as driving time. Local service would still be likely to divert most of the present transit users with trip origins in these towns or Medway, but would not divert as many auto trips. Local Millis Line service would not be faster than Framingham/Worcester Line service from any point in Sherborn, but a small number of Sherborn residents who now use Needham Line stations would be diverted. Based on travel time elasticity formulas, the total number of Boston Proper work trips carried by the extension would decrease to about 760, of which 125 would be new transit trips.

Extension Share of Other Boston and Cambridge Work-Trip Markets at 1990 Travel Levels

Using procedures similar to those used for estimating Boston Proper work trips, it was concluded that a Millis extension with peak-period express service could be expected to capture about 20% of the work trips from Medway, Millis, or Medfield to destinations either in Boston outside Boston Proper ("other Boston") or in Cambridge. (Travel to most such destinations by commuter rail would involve a transfer to an MBTA rapid transit or bus route.) From Dover, the extension share of these trips would be about 15%. The Framingham/Worcester and Millis lines together would capture about 15% of

other Boston and Cambridge work trips from Sherborn, with the Millis extension alone serving at most 3%.

The 1990 Census results show totals of 1,020 work trips to other Boston and 220 to Cambridge from Medway, Millis, or Medfield. From Dover the respective totals are 180 and 60. From Sherborn they are 110 and 75. Applying the factors above to these would result in 235 trips to other Boston and 55 to Cambridge, or a combined total of 290. Survey results indicate that about 75 of these are already made by mass transit, so assuming that all of the latter would be diverted, 215 would be new transit riders. With local service, longer travel times would reduce the extension share of these trips to about 210 to other Boston and 45 to Cambridge, or a total of 255. Of these, 180 would be new transit trips.

Extension Share of Other Travel Markets

Boston and Cambridge Non-work Trips

In the preceding sections, the estimated number of work trips to all of Boston and Cambridge that would be captured by a Millis extension total 1,145 with peak-period express service or 1,020 with local service at all times. The 1993 survey results show that for the South Side lines as a whole, work trips accounted for 89% of all trips with final destinations in Boston or Cambridge. Applying the same factor to the estimates for a Millis extension results in an estimated 140 non-work trips to Boston or Cambridge with express service, of which 60 would be new transit trips. With local service, these figures would decrease slightly, to 125 total and 45 new. Trips to Boston or Cambridge for all purposes would then total 1,285 with express service, including 460 new transit trips or 1,145 with local service, including 350 new transit trips.

Trips to Destinations Outside Boston or Cambridge (excluding interzone)

The survey results also showed that for South Side lines as a whole, 96% of all non-interzone trips (i.e. all trips either to or via South Station, Back Bay or a station in zone 1A or 1B) for all purposes were destined for Boston or Cambridge. With similar proportions, a Millis extension with express service would be expected to attract about 55 non-interzone riders with destinations outside Boston or Cambridge. With local service this figure would drop to 50. Survey results indicate that present mass transit alternatives are not serving any of these trips, so any that were served by the extension would be new transit trips.

Interzone Ridership

Interzone ridership accounts for under 1% of weekday trips on present South Side lines. This may, however, be more a reflection of the locations of rail stations relative to suburban trip attractions than of inherent unattractiveness of commuter rail for suburb-to-suburb travel. In the demand estimates for a Millis extension, interzone trip possibilities specific to this route were taken into consideration.

Millis extension trains would follow the present route of Needham Line trains between Needham Junction and Back Bay. Under the Local service alternative, Millis trains would stop at all stations now served by Needham Line trains. Trips destined to any station from Needham Junction through Roslindale would be classified as interzone. Excluding return halves of reverse-commuting trips (discussed separately below) the 1993 survey results indicate that about 1.5% of passengers boarding trains at stations in Needham alighted at one of the four stations in West Roxbury. With a similar ratio to the number of through trips estimated above, a Millis extension would be expected to serve about 20 interzone trips per day to stations in West Roxbury.

Under the Express/Local service alternative, peak-period Millis trains would serve Needham Junction and Hersey but omit all other stops until Ruggles. Passengers making interzone trips to any of the West Roxbury stations would have to change trains. This would be likely to reduce ridership compared with the prediction of 20 for direct service. About half of the interzone trips from Needham to West Roxbury consist of pupils commuting to private schools. Information on the number of pupils at these schools residing in towns in the Millis extension service area is not readily available; because of the greater distance and lower population density it would be expected to be much smaller than the number residing in Needham. Therefore, an estimate of 10 or fewer interzone trips to West Roxbury from the Millis extension corridor is most reasonable.

The number of Needham Line riders making trips entirely within Needham is very small, partly because of the short distance between stations. The longest possible interzone trip in the town is from Needham Heights to Hersey. This is 2.6 miles by rail, but less than two miles by road. It is also possible to travel between Needham Heights, Needham Center and Needham Junction by MBTA bus Route 59, which has more frequent service and a lower fare than the train. Stations on a Millis extension would be further from stations in Needham, and there is currently no public transportation service to Needham from the extension corridor. Therefore, to estimate interzone ridership potential to stations in Needham, present reverse-commuting volumes to Needham were examined.

Passenger counts taken in 1994 showed a total of 44 passengers alighting from outbound trains in Needham during A.M. peak hours. These trips would have accounted for 1.7% of daily ridership on the line. The 44 alightings included 7 at Needham Center and 10 at Needham Heights. Millis trains would not serve either of these stations directly, so to reach them passengers from the extension would have to transfer to an outbound train or a Route 59 bus or walk. Schedules of connecting trains and buses would be determined by considerations other than the needs of transfer passengers, so it cannot be assumed that convenient transfer service would be available. The walking distances from Needham Junction would be about 0.7 miles to Needham Center or 1.6 miles to Needham Heights. For these reasons, use of a Millis extension for travel to destinations in Needham nearest to Needham Center or Needham Heights would be insignificant. Of the remaining 27 outbound alightings in Needham, 12 occurred at Hersey Station, and were made by students from Boston neighborhoods

heading for a nearby private school. Population density is much lower along the extension corridor than in the sections of Boston served by the Needham Line, so it is unlikely that student ridership from the extension to Hersey station would be close to the 12 reverse-commuting trips counted there.

The considerations above would leave Needham Junction as the only station in Needham likely to attract interzone riders from the extension. The 15 reverse commuting trips observed there accounted for about 0.5% of daily ridership on the Needham Line. With a similar ratio to the number of through trips estimated above, a Millis extension would be expected to serve about 5 interzone trips per day to Needham Junction.

It would also be possible for Millis trains to serve interzone trips between stations on the extension itself. From Millis, such trips could go either to Medfield or to Dover. From Medfield, the only other station further inbound would be Dover. In Medfield, the route of the Millis extension does not pass directly through the business district. Any station site in the town would be at least one mile from most employment sources. The distance from a station in Millis to a station in Medfield would be less than three miles. For these reasons it is unlikely that the extension would serve any interzone trips to Medfield. The extension would pass directly through the town center of Dover, but there are no large employment sources there. Therefore, it is also unlikely that the extension would serve any interzone trips to Dover.

Reverse Commuting Ridership

A Millis extension could also serve some reverse-commuting trips, but based on the experience on existing Boston commuter rail lines, these would not be a substantial ridership component. A high proportion of present reverse-commuting trips by rail are made not by workers but by students attending colleges or private schools near stations. There are no schools along the extension route that would have large numbers of students commuting from other towns. Stations in Dover and Medfield would not attract reverse commuting work trips for the same reasons that they would not attract interzone trips. The Clicquot station site assumed for purposes of analysis would be in an industrial area, however, within convenient walking distance of the GAF roofing plant and a distribution warehouse for the Ann & Hope discount store chain. The alternate Millis station site near Route 109 would be within walking distance of the Devco Products plant.

On the present commuter rail system, the heaviest reverse commuting traffic to a suburban office or industrial park is that at Mishawum station in Woburn. Based on passenger counts and survey results, this station serves about 35 daily reverse commuters going to destinations within walking distance. About 80% of these passengers reported walking times of under 10 minutes from the station, or about one half mile, and about 95% reported walking times of 15 minutes or less. (Some additional reverse commuters transfer at Mishawum to vans provided by their employers.) All of the survey respondents boarded in Boston.

The reverse-commuting potential of a Millis station would be far less than that of Mishawum. Destinations of Mishawum reverse commuters are divided among a large number of offices and industrial plants, with total employment greatly exceeding that within walking distance of any possible Millis station site. Mishawum is in fare Zone 2, with a scheduled train time of 23 minutes from Boston. A Millis station would be in Zone 5, and the running time on reverse-commuting trips would be about 49 minutes. At Mishawum, service includes four outbound arrivals in the A.M. peak and three inbound departures in the P.M. peak, accommodating a range of work shifts. At Millis, the most likely operating strategies would provide only one or two trips in each peak period suitable for reverse commuting. Based on all of these considerations, the number of reverse commuting trips to Millis would not be expected to exceed 10 per day.

In the trip categories discussed in previous sections of this appendix, trip purposes are defined by purpose at the inner end, so the return halves of reverse-commuting trips are classified as non-work trips. Since a Millis extension would not serve an unusually large number of reverse-commuting trips, the various factors used above for non-work trips should be sufficient to account for reverse commuters.

Ridership Changes from 1990 to 1996 and Future Years

At 1990 travel levels, the estimated total ridership to all destinations for all trip purposes on a Millis extension would be 1,200 inbound trips per day if local service were provided at all times. With express service during peak hours and local service during off-peak hours, boardings would increase to 1,320 per day.

As discussed above, work trips to Boston would account for the largest portion by far of ridership on a Millis commuter rail extension. Therefore, in estimating ridership in future years, it is most important to examine changes in work travel. The most comprehensive information on work trips is that provided by the U.S. Census Journey-to-Work survey. This is conducted in conjunction with the regular decennial Census, so the most recent figures available are from 1990. Some changes in travel patterns would be expected in the six years since these figures were collected, and institution of commuter rail service implies a relatively long-term investment in fixed facilities. Thus, it is important to try to update the 1990 figures both to the present and to various future years.

Adjustment from 1990 to 1996

Between census years, the Census Bureau prepares estimates of population for states, counties, and municipalities at two-year intervals. Town-level figures are based largely on a sampling of information contained in income tax returns. The estimation process takes considerable time to complete. The most recent estimates are for population as of July 1, 1996, and these were released in the fall of 1997. These estimates do not include any journey-to-work information.

The Census population estimates for towns in the Millis extension service area indicate overall population growth of about 9% since 1990. As a result of economic conditions, however, overall Boston and Cambridge employment was essentially the same in 1996 as in 1990. Since work trips to Boston and Cambridge would be the predominant source of ridership on a Millis extension, it was concluded that forecasts based on 1996 conditions would not differ significantly from those using the 1990 data.

Projected Demand for Year 2020

The five towns that would account for most of the ridership on a Millis extension (Dover, Medfield, Millis, Medway, and Sherborn) are all in the Metropolitan Area Planning Council (MAPC) Region. MAPC projects overall population increases in each of these towns to be substantially higher than the regionwide average. Specifically, between 1990 and 2020 growth is projected to be 34% in Dover, 24% in Medfield, 17% in Millis, 46% in Medway and 22% in Sherborn. In the same time span, population in the MAPC region as a whole is projected to increase by only 5%.

Upper-bound estimates of ridership in the year 2020 can be obtained by assuming that the numbers of residents of towns in the Millis extension service area employed in Boston or Cambridge will increase at the same rate as total population of these towns and that the commuter rail shares of travel from these towns will remain the same as estimated with current travel levels. Under these assumptions, total boardings at stations on a Millis extension in the year 2020 would be 27% higher than at current travel levels. This would result in total weekday inbound boardings of 1,545 with local service at all times or 1,735 with peak express and off-peak local service.

In the 1990/1996 demand forecasts, work trips to Boston or Cambridge would account for 85% of the ridership on a Millis extension. Work trips to Boston alone would account for 95% of the combined Boston and Cambridge work trips using the extension and for 81% of the total trips. Therefore, future ridership changes would be influenced most by changes in the number residents of the towns in the extension area employed in Boston. MAPC's projected employment increase in the city of Boston between 1990 and 2020 is only 5%, or the same as the overall population increase forecast for the region. For Boston employment among residents of the extension service area to increase at a significantly greater rate than this, it would be necessary either for a disproportionate share of new Boston jobs to go residents of the area, for large numbers of area residents to replace residents of other towns in Boston jobs, or for large numbers of Boston workers to move to the service area from other towns. Since all five towns are expected to experience much higher than average population growth, it is likely that they will also experience above-average rates of growth in the number of residents employed in Boston, so the 5% growth rate for Boston should represent a lower bound on ridership growth. With 5% growth, boardings at stations on a Millis extension in the year 2020 would be 1,270 with Local service or 1,430 with Express/Local service.

APPENDIX H - HISTORY OF MILLIS EXTENSION CORRIDOR PUBLIC TRANSPORTATION SERVICE

Past Rail Passenger Service

Summary of Final Years

Rail passenger service on the segment of the Millis Line between Needham Junction and Millis Station was discontinued in April 1967. Service beyond Millis to Medway and West Medway had ended one year earlier. During the final year, service was operated by the New York, New Haven & Hartford Railroad (New Haven Railroad) under a subsidy agreement with the MBTA covering several routes within the MBTA district. Because of low ridership, the Millis Line was not included when the contract was renewed in 1967.

Service on the Millis Line had been reduced to one round trip per day, inbound in the A.M. peak and outbound in the P.M. peak in 1955, and had not exceeded three round trips per day since before World War II. In the final years, service was usually provided with self-propelled railcars, connecting at Needham Junction with through trains to Boston. Earlier history of this railroad route is presented below.

Construction of the Millis Line

Construction of the railroad route referred to in this report as the Millis Line was originally promoted by mill owners in towns in the upper Charles River Valley, as a means of keeping their transportation costs competitive with those in towns that already had rail service. According to a town history of Medway (of which Millis was once a part) efforts to bring a railroad to that town began in 1837, only two years after the first Boston-area railroads had been completed to Worcester, Lowell and Providence. Passenger transportation between Medway, Medfield and Boston in the mid 1830s was provided by a stage coach running three days per week with northbound and southbound trips on alternate days. At typical coach speeds, a trip from Medway to Boston would have taken at least six hours, not including meal stops.

Little progress was made on the Medway railroad project until 1849, when the Massachusetts legislature granted a charter to the Charles River Branch Railroad for a route from Brookline Village through Newton and Needham to Dover. From Brookline Village to Boston, trains of the Charles River Branch were to use the tracks of the Boston & Worcester Railroad's Brookline Branch and Main Line to the B&W terminal at Lincoln and Beach Streets. (The Brookline Branch had opened in 1848.)

In 1851, a separate company, the Charles River Railroad, was chartered to continue the Charles River Branch from Dover through Medfield and Medway to Bellingham. The first section of the Charles River Branch Railroad went into operation between Brookline and Newton Upper Falls in November 1852. A further extension to Needham Plain (now Needham Center) opened in June 1853. The Charles River Branch was

merged into the Charles River Railroad in November 1853, but no progress on further construction beyond Needham was made by these companies.

In October 1855, the Charles River Railroad was merged into the New York & Boston Railroad. The latter was part of a Connecticut-based project to build a railroad route between Boston and New York on a direct, or "Air Line" route, but no construction work had as yet been completed by this company.

From 1852 to 1858, the Charles River Branch and successors were run under contract by the Boston & Worcester. From 1858 to 1861, the Charles River line was operated by the construction firm of Goss & Munson which used it to haul gravel from Needham for filling of the Back Bay.¹⁴ Passenger service was also maintained during this time.

In November 1861, the New York & Boston finally opened its extension from Needham Center to Medway, and began operating its own trains for the first time. (The Needham gravel operation also continued using the tracks for several years after that.) Further extensions opened to West Medway in 1862 and to Woonsocket, Rhode Island in 1863, but the New York Air Line route was never completed.

Changes in Ownership, 1865-1898

In 1865, the New York & Boston Railroad was sold to the Boston, Hartford & Erie Railroad, which was attempting to assemble a railroad route from Boston through Hartford to the Hudson River. The BH&E had previously purchased the parallel Norfolk County Railroad, which ran from Dedham to Blackstone. (Most of this route is now part of the MBTA's Franklin Branch.) The Norfolk County Railroad was the BH&E's preferred route into Boston, but a dispute with mortgage-holders prevented the new owners from taking possession of the Norfolk County until 1867. Once that occurred, the BH&E had little need for the New York & Boston, or Woonsocket Line, but retained it as a secondary route instead of selling it to a potential competitor.

The Boston, Hartford & Erie Railroad went into bankruptcy in 1870, and was succeeded in 1875 by the New York & New England Railroad (NY&NE). As a result of lobbying by residents of the south side of Newton who were dissatisfied with passenger service on the Woonsocket Line, the NY&NE sold the portion between Brookline Village and Cook Street in Newton Highlands to the Boston & Albany Railroad (B&A) in 1883.¹⁵ This portion of the line, along with the Brookline Branch, became the B&A's Highland Branch. In 1886, a connecting line from Cook Street to the B&A Main Line at Riverside was completed, and Highland Branch service was extended to Riverside. (Most of the Highland Branch is now part of the D Line of the MBTA Green Line.)

¹⁴Some accounts erroneously indicate that the Charles River Branch was originally built for hauling gravel, but the first contracts for filling the Back Bay were not let until over five years after the Charles River Branch commenced operation.

¹⁵The Boston & Worcester Railroad had merged in 1867 with the Western Railroad to form the Boston & Albany Railroad.

The New York & New England Railroad was succeeded in 1895 by the New England Railroad, which was controlled by the New Haven Railroad. The New Haven leased the New England in 1898.

Changes in Passenger Service Operations, 1886-1906

After the opening of the connection from Riverside to Cook Street in 1886, most trains from the Woonsocket Line were combined with B&A Highland Branch trains between Cook Street and Boston. This proved to be unsatisfactory, as inbound B&A trains were frequently either delayed by late arrivals of trains from the Woonsocket Line or departed without waiting for the connection. To remedy this problem, the New Haven Railroad investigated alternate routings for Woonsocket service. The solution chosen was to build a connection from the West Roxbury and Dedham Branch of the Boston & Providence Railroad (then also part of the New Haven system) to the Woonsocket Line in Needham.¹⁶

The new link, from a point near West Roxbury Station to the present Needham Junction Station, was completed in November 1906.¹⁷ All trains from Boston to points on the Woonsocket Line south of Needham Junction were immediately shifted to the new route. Service on that segment reached its all-time maximum at that time, with eight round trips between Boston and Woonsocket and one round trip between Boston and Bellingham Junction, continuing to Franklin Station via the Milford Branch. (The Franklin trains were soon cut back to West Medway.) Only two round trips south of Needham Junction provided schedules suitable for Boston work travel, as there was then relatively little demand for such service from communities along the line. Most trains using the new connection ran non-stop between Needham Junction and Back Bay, with service to stations in West Roxbury still being provided by Dedham trains.

Woonsocket trains no longer passed through the stations at Needham Center, Needham Heights, or Newton Upper Falls. To maintain service to those stations, shuttle trains were run between Needham Junction and Newton Highlands, making close connections at Needham Junction with Woonsocket trains. Boston passengers could also transfer to or from B&A Highland Branch trains at Newton Highlands, but most of the connections there were not as close as those at Needham Junction. In addition, a few through trains were run from Newton Highlands or Needham Center to Boston via Needham Junction, mostly during peak hours.

Changes in Passenger Service Operations, 1911-1917

Through service from Boston to stations north of Needham Junction was increased in 1911, when most of the former shuttle connections were replaced either with through

¹⁶The West Roxbury and Dedham Branch had opened from Forest Hills on the B&P Main Line through West Roxbury to Dedham in 1850.

¹⁷Needham Junction was originally the only station on the new line. Bird's Hill (now Hersey) station in Needham was added in 1917.

trains from Needham Junction to Boston via Newton Highlands or with circuit trains running out from Boston to Needham Junction via Newton Highlands and in through West Roxbury or vice versa. Most Woonsocket trains still ran non-stop between Needham Junction and Back Bay, but most of the circuit trains stopped at West Roxbury, Bellevue, Highland and Roslindale. The West Medway round trip was cut back to Medfield Junction at about the same time.

The New Haven Railroad was forced to discontinue through service to Boston via Newton Highlands in 1914, as the result of anti-trust action. Most of the circuit trains were replaced either with through trains from Boston to Newton Highlands via West Roxbury or with shuttle trains between Needham Junction and Newton Highlands.

In 1917, all U.S. railroads were required to reduce levels of passenger service in order to conserve resources for freight transportation during the first World War. As a result, service south of Needham Junction was reduced to six inbound and five outbound Woonsocket trains and one outbound Medfield Junction train per day. The wartime cuts were never restored, but the Medfield Junction train was eventually replaced by another Woonsocket trip.

Changes in Passenger Service Operations, 1920-1941

Declining ridership, partly as a result of greatly increased automobile ownership, led to more service cutbacks during the 1920s. In 1926, all through passenger service between Boston and Woonsocket via Needham Junction was permanently discontinued. In its place, six inbound and five outbound trains a day were run between Boston and Franklin via Needham Junction and Bellingham Junction. A sixth outbound train ran from Boston to Medfield Junction only. Connecting shuttle service between Bellingham Junction and Woonsocket was provided with self-propelled railcars. The New Haven also began operating bus service between Boston and Woonsocket through its subsidiary, the New England Transportation Company about 1928, but the route did not serve any intermediate points on the railroad line. This bus route was discontinued in 1930, but was replaced by other bus service discussed later in this appendix.

In 1927, passenger service between Newton Upper Falls and Newton Highlands was discontinued, and service beyond Needham Heights to Upper Falls was reduced to two trips each way per day.

In 1930, all passenger service south of Bellingham Junction ended. At about the same time, service north of Bellingham Junction was reduced to three Franklin round trips and one West Medway round trip through to Boston, plus one round trip from Franklin to Needham Junction connecting there with trains for Boston. Passenger service between Needham Heights and Newton Upper Falls ended in 1932. The track between Bellingham Junction and Woonsocket Junction (near the state line) was abandoned in 1934, ending any possibility of service restoration on that segment.

The New Haven Railroad declared bankruptcy in 1935. This resulted in extensive abandonments of branch lines and cutbacks in passenger service. All remaining Franklin and West Medway passenger trains were discontinued in July 1938, leaving no passenger service on the line south of Needham Junction. As a result of appeals to the Massachusetts Department of Public Utilities, however, the New Haven reinstated one through train each way from Franklin to Boston via Bellingham Junction and Needham Junction in March 1940. After a two-month trial, this service was discontinued and replaced with two round trips from Needham Junction to West Medway and one round trip to Caryville. All trips were run with self-propelled railcars built in the 1920s. Caryville passenger service was discontinued in September 1941, but a third outbound West Medway train was added. The track between Bellingham Junction and Caryville was abandoned the same year. The track between Caryville and West Medway was abandoned in 1949.

Changes in Passenger Service Operations, 1947-1964

The bankruptcy reorganization of the New Haven Railroad was completed in 1947, but this had little effect on passenger service south of Needham Junction. Train frequency between West Medway and Needham Junction remained at two inbound and three outbound trips per day until April 1951, when a third inbound trip was added. Service was cut back to one inbound A.M. peak and one outbound P.M. peak trip later in 1951, however. In April 1954, an evening inbound trip was added, running through to Boston, but it was discontinued a year later. After that, there was never more than one trip each way per day on the line.

It should be noted that because of a lack of layover facilities at West Medway, the equipment used on the line after 1940 was usually based either at Needham Junction or in Boston. Changes in the number of trains shown in schedules during the early 1950s resulted from changes in policy on carrying passengers on off-peak direction trains operated mainly for equipment positioning. One of the three outbound trains shown between 1941 and 1951 was an early-morning trip. The third inbound train shown briefly in 1951 was an evening return move, as was the second inbound train of 1954-56.

Beginning in 1954, the usual passenger train equipment on the Millis Line was a single self-propelled Budd Rail Diesel Car (RDC) from a fleet bought new by the railroad during the early 1950s. Initially, these were run as connecting trains to Needham Junction. From 1960 to 1963, the inbound and outbound West Medway cars were run through from Needham Junction to Boston on the end of Needham Heights trains, although schedules still indicated that a transfer was required. From 1964 until the end of service in 1967, only the evening outbound car normally ran through from Boston.

End of Passenger Service on the Millis Line

The New Haven Railroad declared bankruptcy again in 1961. Discontinuance of all passenger service on several lines including those to Needham Heights and West Medway was approved by the Interstate Commerce Commission effective in April 1966.

The MBTA had previously entered an agreement with the New Haven to subsidize continued operation of this service at the existing levels if the discontinuance was approved. At that time, the MBTA was only authorized to contract for service within its district, unless funding for outside service was provided from another source. Dover, Medfield and Millis are in the district, but Medway is not. Medway chose not to fund continued service, so the end of the route was cut back to Millis Station when the MBTA contract took effect. When the subsidy contract was renewed in 1967, the Millis trains were excluded because of low ridership.

Ridership and Mode Share in Final Years

Passenger counts for the final year of operation on the Millis Line are not readily available. Counts taken in 1963 show that the single inbound trip was carrying an average of 25 riders per day. Boardings averaged 10 at West Medway and Medway combined, 5 at Millis and Clicquot combined, 5 at Medfield Junction and Farm Street combined and 2 at Dover. Two others boarded at Charles River Station in Needham.¹⁸

At the time that this service ended, the towns along the line had much lower total population and lower Boston work-trip orientation than they have now. The combined 1965 population of Medway, Millis, Medfield, and Dover was 23,200. The estimated total population in the same towns in 1996 was 36,206, or an increase of 56%. The results of a home interview survey conducted in 1963 for the Eastern Massachusetts Regional Planning Project show that work trips to Boston Proper from these towns by all modes of transportation then totaled 578 per day.¹⁹ In 1990, the total was 1,173, or a gain of 103%. The gain in Dover alone was 200%.

If all of the commuter rail boardings on the Millis Line in 1963 were work trips to Boston, they would have represented a mode share of under 4%. The Census results indicate that the total transit share of Boston work trips at the time was 40%. Ridership on the Milford-Boston express bus or on commuter rail routes other than the Millis Line would have explained this discrepancy.

Changes in Millis Line Freight Operations and Track Ownership Since 1967

Because of limited demand for freight service in Medway, the track between West Medway and the present site of the Devco Products industrial plant in Millis was abandoned and removed in 1967. The assets of the bankrupt New Haven Railroad were acquired by the Penn Central Company in December 1968, but Penn Central declared bankruptcy in June 1970. For many years, freight service on the Millis Line had been provided by trains originating at Framingham and accessing the route from the Framingham Secondary Track at Medfield Junction. To reduce maintenance costs, Penn Central removed the diamond crossing between the northern and southern halves of

¹⁸See Systems Analysis and Research Corporation *Supplement No. 3 to Mass Transportation in Massachusetts. A Final Report on a Mass Transportation Demonstration Project* May 1964

¹⁹See Boston Redevelopment Authority *Transportation Facts of the Boston Region. Second Edition.* 1968

the Millis Line at Medfield Junction about 1971. The segment from Medfield Junction to Needham Junction was then designated as the Dover Secondary Track, and that from Medfield Junction to Millis as the Clicquot Secondary Track.

In December 1971, Penn Central agreed to sell 146 miles of active and abandoned rights-of-way in Massachusetts to the MBTA. This sale was finalized in January 1973. It included the Needham Branch and the Dover and Clicquot Secondary tracks, but not the abandoned right-of-way west of Millis. (This is discussed further in appendix F.) Penn Central retained perpetual rights to operate freight service on all of the lines included in this transaction. The Clicquot Secondary Track still served on-line industries in Millis. The Dover Secondary Track was used only as a connecting link to reach industries on the Needham Branch in Needham, Newton, and West Roxbury.

In April 1976, Penn Central ceased to be an operating railroad. Freight service on all Penn Central lines in Massachusetts was taken over by the newly established Consolidated Rail Corporation (Conrail) or other railroads, or was discontinued at that time. Freight service on the Dover and Clicquot Secondary tracks and on the portion of the Needham Branch between Needham Junction and Newton Upper Falls was initially included in the Conrail system. Service between Needham Junction and West Roxbury was discontinued in 1976, but was resumed in 1978 by Conrail under a subsidy agreement with EOTC partly funded by the freight user on that line.

Most of the industrial sites in Needham and Newton were redeveloped for retail and office use during the late 1970s. This resulted in the loss of most of the rail freight traffic to those areas and led to a decision by Conrail to discontinue service on the Dover Secondary Track and Needham Branch as part of a systemwide downsizing. Effective in June 1982, operation of these lines was taken over by the Bay Colony Railroad under agreement with EOTC. Conrail continued to operate freight service on the Clicquot Secondary Track until September 1987, when Bay Colony also took over that operation. Bay Colony has continued as the operator since then. Cars for all segments of these lines are interchanged between Bay Colony and Conrail at Medfield Junction.

Bay Colony initially subcontracted operation of the line north of Medfield Junction to the Springfield Terminal Railway, which provided motive power with a trackmobile,²⁰ which was transported among several rail lines on a flatbed trailer. Bay Colony subsequently assumed direct operation of this service with a conventional switching locomotive which was kept on a side track in Upper Falls when not in use. Engines used on the lines north and south of Medfield Junction are now based at Clicquot.

²⁰Trackmobiles, used most often for switching within industrial plants, are rubber-tired vehicles that can operate either on pavement or on railroad tracks, guided by movable flanged wheels.

Past and Present Bus Service in the Millis Line Corridor

Summary

The through bus route between towns in the Millis Line service area and Boston has been operated by the Brush Hill Transportation Company since August 1973, when the previous operator went out of business. Funding of this route under the MBTA/EOTC Interdistrict Transportation Service (IDTS) program began in September 1987. The present service level of two round trips per day has been in effect for most of the time since then, except for an experimental increase to three trips in 1988. The maximum level of service provided on the route after 1973 was seven inbound and six outbound trips, plus an outbound short-turn to West Medway.

Bus service between Milford and Boston via Routes 109 and 128 and the Mass. Turnpike was first established in 1967, as a variation of an older route that used Route 109 south of Route 128 but followed local streets from Route 128 via Forest Hills Station to downtown Boston. The older routing was discontinued when Brush Hill took over Milford service in 1973.

Through bus service to Downtown Boston from towns in the Route 109 corridor originated in 1938, supplementing service to Charles River Loop (West Roxbury) that had been in operation since 1928. The authorization to extend bus service directly into downtown Boston was probably related to the 1938 discontinuance of commuter rail service on the Millis Line. The older bus route had been a replacement for trolley service that had been established in the early 1900s. A more detailed history of these routes appears below.

Street Railway Predecessors of Milford-Boston Bus Route

On May 9, 1899, the Norfolk Western Street Railway opened a trolley line from Dedham Square to Medfield. Starting from Washington and High Streets in Dedham, this route ran on High Street to the present state Route 109 at Bridge Street. It then followed Route 109 through Westwood and Dover to Medfield Center. At Dedham Square, the Norfolk Western connected with the West Roxbury & Roslindale Street Railway, which had opened from there to Forest Hills via Washington Street in 1896. Further connections from Forest Hills to downtown Boston were provided by trolley lines of the Boston Elevated Railway.

On May 26, 1900, the Medfield & Medway Street Railway, promoted by the same interests as the Norfolk Western, opened an extension of the latter line from Medfield to Franklin via the present Route 109 to Millis, then via Pleasant and Village streets into Medway, and via Sanford and Lincoln streets to downtown Franklin. The two companies were always operated as one entity, with through service being provided from Dedham to Franklin.

At Franklin, the Medfield & Medway connected with a trolley line through Bellingham to Woonsocket, Rhode Island that had been opened in 1899 by the Milford, Attleboro, & Woonsocket Street Railway. Branches from the latter line at Bellingham Four Corners (Mechanic Street at Maple Street) ran north through North Bellingham to Caryville and northwest through Bellingham Center to Milford. The Medfield & Medway also connected at Medway with a branch of the Milford, Holliston & Framingham Street Railway through West Medway and Caryville to Milford. (The MH&F was merged into the Milford & Uxbridge Street Railway in 1902.)

By using a combination of the trolley lines described above, it was possible by 1901 to travel between Boston and most points between Medfield and Woonsocket served by the New Haven Railroad's Woonsocket Line. Such travel was promoted in detailed guidebooks instructing passengers on the necessary connections. Long trolley trips were much more time-consuming than train trips, but for casual riders the trolleys offered more frequent departures and a greater choice of boarding and alighting points at lower fares than the trains. The trolleys were also quite competitive with the trains for travelers making strictly local trips.

Most segments of this trolley network had service every 30 to 60 minutes all day. The Woonsocket railroad line had at most nine trains each way per day. When the Medfield & Medway Street Railway first opened, a travel time of 2 hours, 20 minutes from Medway to downtown Boston was advertised. Completion of the elevated rapid transit line from downtown Boston to Forest Hills in 1909 reduced this to 1 hour, 51 minutes. For comparison, the peak scheduled railroad time from Medway Station to South Station was then 58 minutes. There was very little private automobile travel for such distances at the time.

The Norfolk Western Street Railway was sold at foreclosure to a new company, the Dedham & Franklin Street Railway, in 1904 but unified operation with the Medfield & Medway continued. The Dedham & Franklin Street Railway and the Medfield & Medway were both placed in receivership in 1912, and were reorganized in 1914 as the Medway and Dedham Street Railway. This company in turn leased the property to the Milford & Uxbridge Street Railway for operation. This arrangement lasted until September 1922, when the lease was canceled. The Medway & Dedham Street Railway then assumed direct operation of the portion of the line between Dedham and Medway, with the remainder of the route to Franklin being abandoned. The Medway & Dedham Street Railway went out of business in November 1924, and the line was scrapped.

Bus Replacement of Street Railway Routes in Millis Line Corridor

At the same time that the Medway & Dedham Street Railway ceased operations, a new company, Medway and Dedham Bus Lines, was organized to run bus service over the former trolley route from Dedham through Medway to Franklin. In 1928, the Milford & Uxbridge Street Railway went out of business, with replacement bus service being divided among several different companies. The former M&U route from Medway through West Medway and Caryville to Milford was replaced by bus service operated

by Medway and Dedham Bus Lines. Through service was run between Dedham and Milford, with service between Medway and Franklin becoming a connection. During the same year, M&D service was extended from Franklin through Bellingham to Woonsocket in place of another abandoned trolley line. The M&D also began extending selected trips from Dedham Square to the Spring Street (Charles River Loop) streetcar terminal of the Boston Elevated to obtain faster downtown Boston connections.

In 1929, Medway & Dedham Bus Lines formed a common management with Johnson Bus Lines, which had been operating replacement bus service for various abandoned trolley lines in the Milford area for several years. Thereafter, business was conducted under the Johnson name. The two companies formally merged in 1937. Johnson began running through service from Spring Street to Woonsocket via Franklin in addition to Spring Street - Milford service in 1931, after Boston-Woonsocket bus service provided by a subsidiary of the New Haven Railroad had been discontinued.

In 1938, Johnson Bus Lines was authorized to operate service directly to the Greyhound Bus terminal at Park Square in Boston in place of the Spring Street connection. Through service was initially run only from Woonsocket, with limited stops. Milford service was also extended to Park Square in 1939. North of Dedham Square, buses were routed via Washington Street and Columbus Avenue. The only intermediate stop in this section was at the Forest Hills rapid transit station. Restrictions in the operating rights prevented transportation of passengers between Dedham and points further north. Passengers from Westwood could use the route to travel to Dedham or Forest Hills, but not to downtown Boston.

In 1942, a route variation in Westwood was begun, with some trips using Pond Street between its two intersections with Route 109, to serve a more densely populated area. In 1943, a new alternate routing between Millis and Milford was implemented, using Route 109 all the way instead of running via Pleasant and Village Streets through Medway. This variation, known as the Black Swamp route was used for new limited-stop service between Hopedale, Milford and Boston.

Decline of Bus Service in Millis Line Corridor

In the late 1950s, Johnson Bus Lines implemented major cutbacks in service to Boston as a result of declining ridership. Service from Boston to Woonsocket was discontinued entirely, and most Milford service was run via the older route through Medway instead of the faster Black Swamp routing.

At the beginning of 1963, inbound ridership on the Milford route averaged about 200 passengers per day. During that year, an experimental increase in service from 9 to 16 round trips per day was funded by a temporary state agency, the Mass Transportation Commission (MTC). This resulted in an increase of ridership to 275 inbound passengers. (No breakdown of boardings by town was provided.)

In May 1963, all remaining routes of Johnson Bus Lines were taken over by The Short Line, Inc. a predecessor of today's Bonanza Bus Lines. The Short Line instituted several measures to try to upgrade the Route 109 corridor service. Some of the trips added during the MTC experiment were retained afterward, and several trips were extended beyond Milford to Woonsocket via Bellingham Center. Some service was also run from Woonsocket to Boston via Franklin. In 1967, some trips were re-routed into Boston via Route 128 and the Mass. Turnpike instead of via Forest Hills, reducing travel time to downtown Boston by about 10 minutes. By 1968, all Milford trips used the older routing through Medway rather than the Black Swamp route.

All of these changes failed to produce satisfactory results, and in October 1968 Short Line sold the Woonsocket and Milford to Boston service to The Gray Line, Inc. Changes made by Gray Line included running more of the Milford trips via the Mass. Turnpike routing or via Black Swamp and more of the Woonsocket trips via Franklin. In Boston, buses began serving South Station in addition to Park Square. Still, service remained unprofitable. In December 1972 Gray Line sold the routes to Overland Stage Coaches, Inc., formerly mostly a charter bus company. After a few months, Overland announced that the service would be discontinued unless an operating subsidy were offered by the MBTA, the state, or local communities. Failing to get such a subsidy, the company ceased operations in August 1973. Emergency authority was immediately granted by the Department of Public Utilities to the Brush Hill Transportation Company to continue all service previously run by Overland Stage Coaches. Brush Hill did not reinstate service to Woonsocket or Franklin, and routed all trips to Milford via Route 109 (Black Swamp route) instead of via downtown Medway and Caryville. All service was routed into Boston via the Mass. Turnpike.

Permanent authority for this service was granted the Plymouth & Brockton Street Railway Company, under the same ownership as Brush Hill, in December 1973, but Brush Hill continued to be the actual operator of the route. In 1977, five round trips per day were still being operated, all during peak hours. A one-day passenger count showed 180 inbound boardings, including 6 in Milford, 27 in Medway, 35 in Millis, 62 in Medfield, and 50 in Westwood. Ridership has decreased greatly since then, and service has been reduced to two peak-period round trips. A one-day count by CTPS in May 1997 showed only 17 Boston boardings on the two outbound trips.

Other Bus Service in Millis Line Corridor

As far as can be determined, the routes discussed above are the only bus routes that have ever been used for through service to downtown Boston from the towns that would be served by a Millis commuter rail line extension. Feeder bus service has apparently never been operated to commuter rail stations in other towns from Medfield, Millis, or Medway. Feeder bus service from Dover was instituted in July 1938, when commuter rail service on the Millis Line was first discontinued. One bus route ran from Dover Station to Needham Junction Station via Dedham and Willow streets in Dover and South and Chestnut streets in Needham. A second route ran from Dover station to Wellesley Square Station via Springdale Avenue, Main Street, and Dover Road in

Dover, Charles River and Grove streets in Needham, and Grove Street in Wellesley. These routes were not continued after the restoration of rail passenger service to Dover in 1940, and they may have been discontinued even earlier.